GY DEPT

*In this Issue*
HOW MUCH AIRCRAFT PRODUCTION?
*By Colonel John H. Jouett*

MAY 1942

# AVIATION

*The Oldest American Aeronautical Magazine*

McGraw-Hill Publishing Company, Inc.

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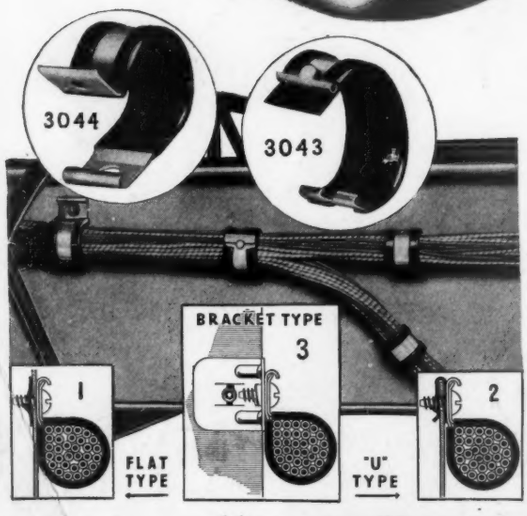


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MAY, 1942

REGULAR EDITION



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# IN THIS ISSUE ★ ★ ★ ★ ★ ★

THE EDITOR'S TALE of Two Factories calls attention to the increasingly important role of "human relations engineering" in the battle for production and in efforts to achieve greater harmony between management and labor (page 69).

AVIATION's War Communique No. 5 explains why, in spite of our soaring warplane production, it will take some little while before American combat planes can throw their weight around and smother the enemy in any single theater of war (page 70).

A Production Report to the Nation by Col. John H. Jouett, describing the present status of the aircraft industry, constitutes a vigorous answer to all who would attempt, either maliciously or unwittingly, to discredit the magnificent performance of the industry. He presents the facts of that performance squarely, omitting only such information as would be of value to the enemy (page 72. Also see photo and caption, this page).

Encouraging Employee Thinking (page 74) tells how RCA's employee suggestion system helped increase production and boosted morale of workers.

We continue our comprehensive series of identification photos and silhouettes of foreign aircraft this month with three full pages of British aircraft (pages 77, 78 and 79).

Frank T. Courtney's stimulating discussion of design and engineering problems involved in remote propeller drives (page 82) leads off the Manufacturing Section this month. It is the first of a series which will cover the subject of flying boat design.

Working Transparent Plastics, by John Sasso (page 86), is a companion article to the Plexiglas story in the April issue. Whereas the latter described correct methods of installation of transparent plastics, Sasso's material deals with proper methods of forming and working, and a subsequent installment will cover machining of transparent plastics.

New developments in design and construction of plants for production of vast quantities of airplanes are described in an article by M. M. Valentine, of the Albert Kahn organization (page 96).

With efficient scrap conservation, John St. Peter of the Aluminum Co. of America estimates that 15 to 20 percent of the industry's sheet aluminum requirements for this year could be met with salvaged aluminum (page 99).

Incidentally, don't overlook the complete index to the Manufacturing Section provided on page 81. This regular feature is designed to aid those primarily interested in that part of the book to find the wealth of material which is too great to list on the contents page or mention here.

In the Military Section, our Washington Editor this month describes the new streamlined organization of the Army Air Forces. It includes a chart that you can understand, too (page 183).

## Coming

The June issue of AVIATION will include an article on mass producing the Douglas A-20's, the light attack bomber which turned in an incredibly fine performance as a night fighter when, during the Battle of Britain, the RAF mounted extra guns, called it the *Havoc* and sent it aloft to repel Nazi night raiders. Its successful accomplishments in making Britain's night skies too hot for the invaders is known to all the world.

Also there will be stories on methods of efficient machine loading evolved at Bell Aircraft, production boosters at Fleetwings, how to speed and expand production through subcontracting, British fighter plane design, a revolutionary new method of forming skin panels by drawing, and scores of other constructive, useful articles, all designed to assist men in every phase of the aviation business to better performance in production and operation of aircraft.

In July comes AVIATION's big War Production number. Aviation is rapidly growing to full stature as the world's greatest mass production industry. New methods, new tools, new machinery are being developed day by day. We propose to present up-to-the-minute, authoritative information on all of these subjects, to the end that all men whose responsibility it is to provide the 185,000 planes called for by the President this year and next may find assistance in carrying out their jobs. More detailed information on this next month.

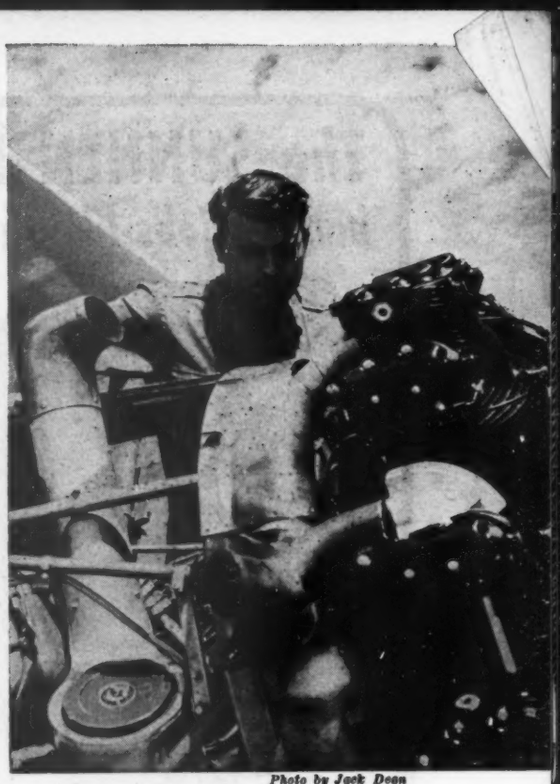

Photo by Jack Dean

*"A clean airplane is a well-maintained airplane," says* SAM MONSCHKE, *maintenance superintendent at Hawthorne School of Aeronautics. Bill Strohmeier's account of how Sam and his crew keep a fleet of Cadet trainers in the air (page 187) will prove helpful to many an operator faced with similar problems.*

Bogan Studio

COL. JOHN HAMILTON JOUETT'S *colorful career constitutes a record of lasting achievements, from his early years at West Point right up to his present key position in aviation as president of the Aeronautical Chamber of Commerce of America. During World War I he was commander of American balloon operations on the Western Front. Jack Jouett went out to China in 1930 to organize a modern air force for the Chiang Kai-Shek regime. The results of the firm groundwork laid then are daily making the headlines these days as China's pilots and the American volunteers chalk up fantastic victories in the face of overwhelming odds.*

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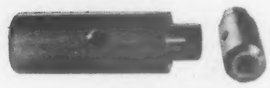
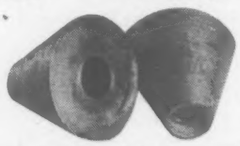


Diesel Engine Fuel Injector Cylinder "So accurate that a piston can be fit within .00005" inch."



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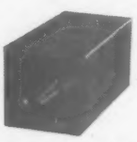
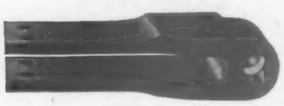


Saved time in producing a smooth accurate finish on this bronze remote control valve body.

"Produced an extremely accurate and glass-like finish."

Aviation Hydraulic Cylinder made of Aluminum-Alloy. Improves the quality of the bearing surface. An extremely smooth surface-finish is secured.



Mild Steel Clevis. Honing was used to correct errors of previous machining and maintain true alignment of the two bearing surfaces of this clevis.

Hardened Steel Inner Bearing Race honed to .00005" limit. Surface finish improved; errors of out-of-roundness eliminated.

Aircraft Valve Tappet Roller. 4-Micro finish.

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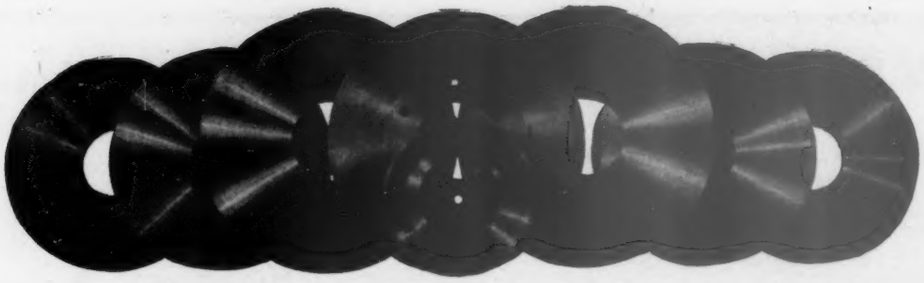

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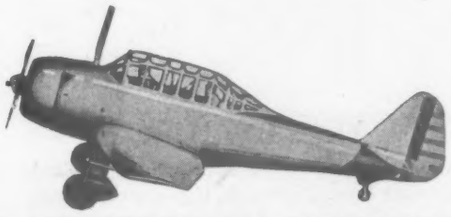

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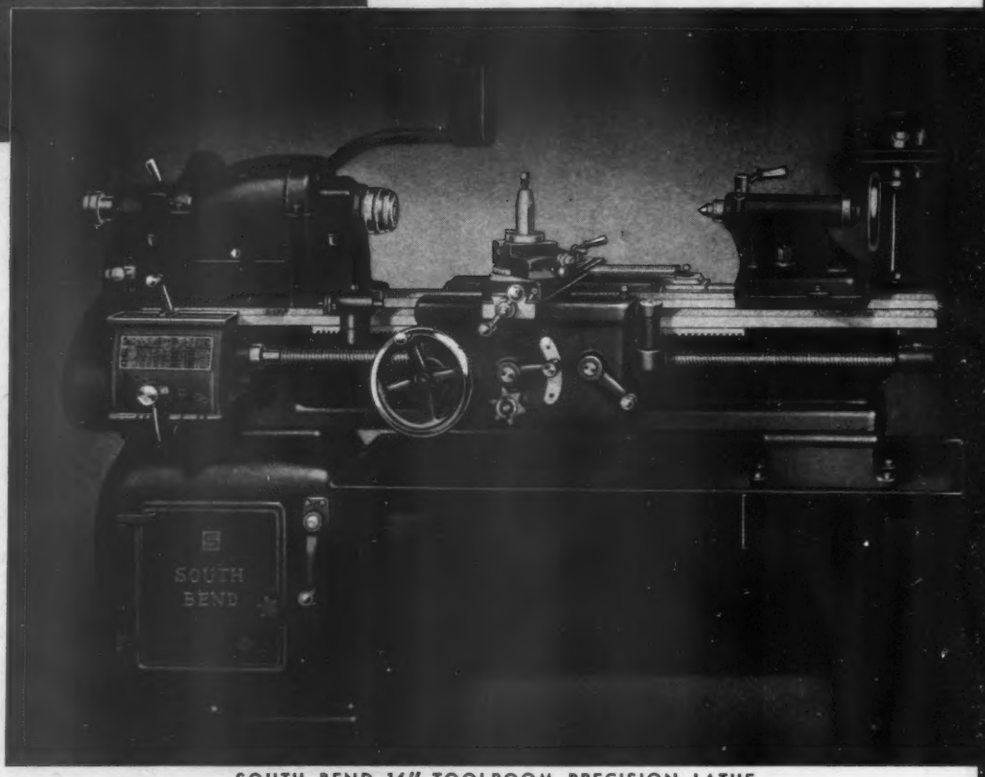


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Omaha, Nebr. . . . Fuchs Mchy. & Supply Co.
Philadelphia, Pa. . . . W. B. Rapp Machinery
Pittsburgh, Pa. . . . Tranter Manufacturing Co.
Providence, R. I. . Reynolds Machinery Co., Inc.
Rochester, N. Y. . . . . Ogden R. Adams
St. Louis, Mo. . . Colcord-Wright Mchy. & Sup.
San Francisco, Cal. . . Moore Machinery Co.
Seattle, Wash. . . . . Star Machinery Co.
Toledo, Ohio. . . . . Reynolds Machinery Co.

**SOUTH BEND LATHE WORKS**

Lathe Builders for 36 Years

177 East Madison Street — South Bend, Indiana, U. S. A.

TRADE MARK SOUTH BEND ENGINE LATHES

LET'S GO! U.S.A. KEEP 'EM ROLLING

# 12 helpers

## TO SAVE YOU

# MAN-HOURS AND MATERIALS

**GOOD IDEAS—always a scarce raw material—may be lurking in these views of G-E equipment at work.**

Perhaps among them there is one that will suggest a way to save a few minutes or cut a few pounds out of your job.

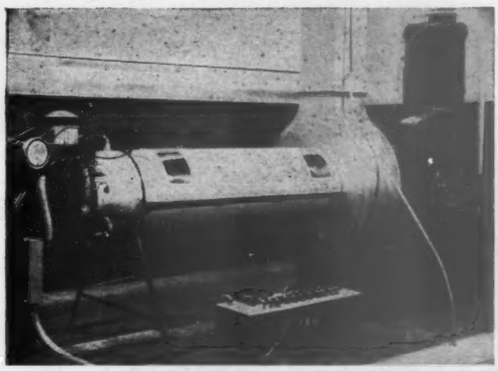
G-E equipment can—*is*—helping cut man-hours per plane, also saving valuable materials. Perhaps we can help you—by keeping you posted on new electrical developments; by simplifying your problem of selecting the proper electric equipment for the job.

The G-E representatives near you are engineers and specialists. You can enlist their help now by reaching for your telephone. *General Electric Co., Schenectady, N. Y.*

*General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.*

INDUSTRIAL CONTROL of all descriptions. Easy to install, easy to maintain, provides coordinated protection for men and machines.

RESISTANCE-WELDING MACHINES for high-speed operation are breaking production records and giving consistent high-quality welds.



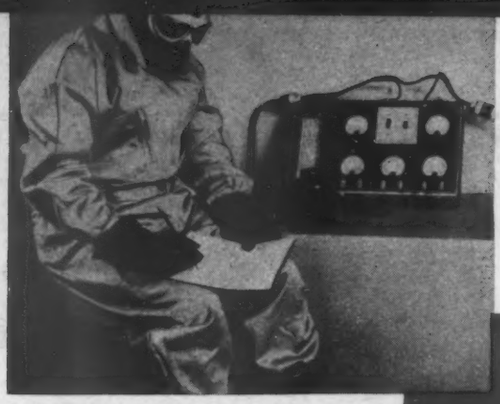
DYNAMOMETERS like this one in an engine-testing laboratory are assisting with every testing job from design to finished product.

WIND-TUNNEL EQUIPMENT such as motors, motor-generator sets, switchgear, and related apparatus are at work improving the technology of U.S. aviation.

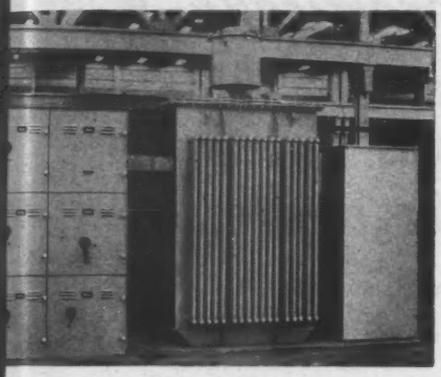
# GENERAL ELECTRIC

# Equipment for the plane, too

TRI-CLAD MOTOR drive on assembly line. Here's a motor with better protection from physical damage, electrical breakdown, or operating wear and tear.



THE ELECTRICALLY-HEATED FLYING SUIT is representative of new developments growing out of constant G-E research and field study.

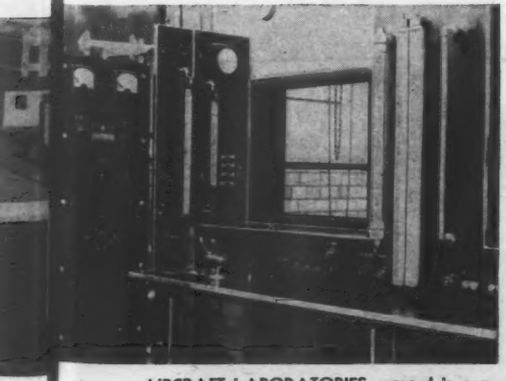


LOAD-CENTER DISTRIBUTION—A better system, in weeks less time, at lower over-all cost, using far less copper.

MOTORS AND CONTROL for machine tools, designed for the job, assure the operating characteristics wanted in the particular tool.

ARC WELDERS and electrodes with the "strike-easy" feature give you the speed and economy of arc welding on many structural parts hitherto riveted.

ELECTRIC FURNACES provide precise heat treatment, minimizing rejects, assuring uniform elasticity and toughness of plane parts.



AIRCRAFT LABORATORIES engaged in complex research, measurement, and testing find G-E test equipment sturdy, accurate, and dependable.

LIGHTING of production space, yard areas and fence lines is being handled by G-E equipment specially designed for the purpose.

A variety of G-E equipment, like that below, is helping to keep 'em flying.

664-1-8872

FROM POWER SUPPLY THROUGH FINAL TEST

G-E Equipment Helps to Get 'Em Flying

PUBLIC LIBRARY
DETROIT MICH

**YOU KNOW WHAT BETTER LIGHTING CAN DO IN YOUR PLANT TODAY...***

*Science says, performance records prove, he can work better, faster, and more accurately with higher quality working daylight, properly distributed.

## ★★★ but do you know how *fast* and *economically* you can get it ★★★ with a MILLER Continuous Wireway Fluorescent Lighting System?

● There is no fluorescent lighting equipment *exactly* like the MILLER *Continuous System*. Built right into it is a continuous wire channel containing *all* operating auxiliaries and conduit. This means hours, *even days*, saved from expensive wiring or rewiring of your plant . . . priority copper and other critical material saved . . . dollars saved, too. It means your new and better lighting *system* goes in, *not* fixture by fixture, but *complete* row after row, all ready to go to work for you.

Worried about *war* production? Any qualified lighting authority will tell you that illumination of 50 foot candles or better in your plant from MILLER 50 FOOT CANDLER or 100 FOOT CANDLER (MILLER TROFFERS in your offices and drafting room) will deliver *more* work and *better* work from more satisfied, eye-fit employees. Write for details and you'll discover you never knew there was such a lighting system as this! (*Representatives in principal cities.*)

***"Fingertip Facts" about the MILLER Fluorescent Lighting System***

**HIGHER ILLUMINATION** . . . 50 to 100 foot candles or more—men work better, faster. ● **30 TO 50% LOWER INSTALLATION COSTS** . . . Make war production dollars go further. ● **FASTER INSTALLATION** . . . Steps up building schedules—plants get into production quicker. ● **SIMPLIFIED MAINTENANCE** . . . Easy-to clean, removable reflectors—save man-hours for production. ● **UNIFORM LIGHT DISTRIBUTION** — Production setup can be changed without need for touching lighting.

**MILLER**

**50 FOOT CANDLER**
**100 FOOT CANDLER**
**MILLER TROFFERS**

**Continuous Wireway Fluorescent Lighting Systems**

**THE MILLER COMPANY**
**MERIDEN, CONN.**
*Pioneers in Good Lighting Since 1844*
● **MILLER offers a complete line of filament and fluorescent lighting equipment**



PUBLIC LIBRARY
Detroit Mich

**"SO I'M A 'GAMBLER' —SURE!"**

"If you call it 'gambling' to test new methods on a trial basis, to prove conclusively that the new method is superior, to install Por-os-way and up my grinding production amazingly—then, sure, I'm a 'gambler'!"

# Prove how porous, honeycomb structure ups grinding speed—even with unskilled operators!

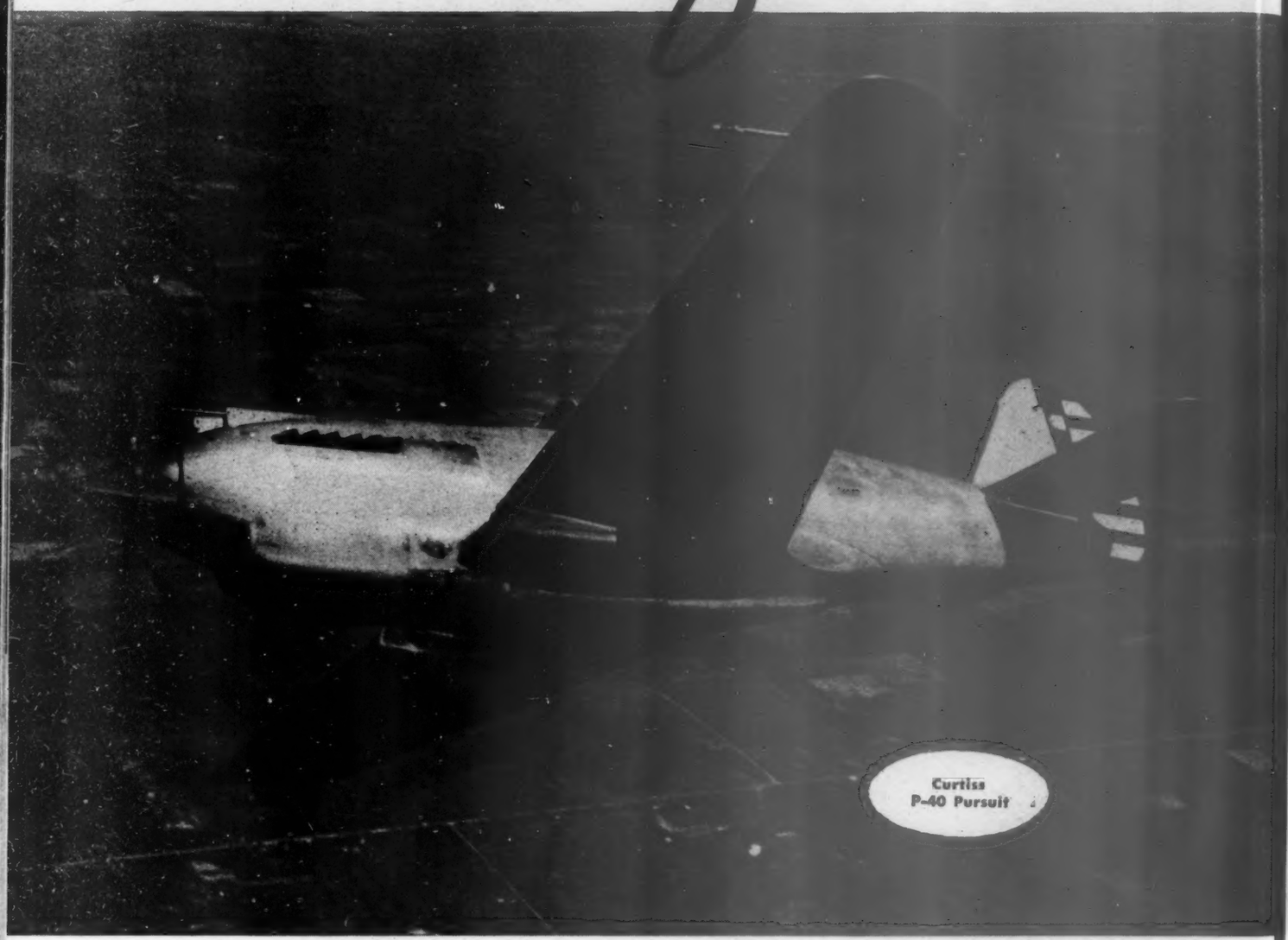
Copyright 1942, by A. P. DE SANNO & SON, INC.

FROM THREE YEARS of research in our laboratories comes this new type of precision grinding wheel. Por-os-way is *porous*, not sandy in texture. Millions of air cells separate contact points. Between contacts each grinding point is therefore cooled. This means a cooler grinding wheel that will operate at faster feeds or deeper cuts. Actually, Por-os-way increases grinding speed 100% to 400% on regular cuts or at your regular feed will take cuts .010" or deeper. Each man, each machine, does 2 to 5 times more!

Por-os-way's unique structure—like a sponge—results from a new method of manufacture and a new bonding agent. The cellular structure of the bond is controlled. Besides grade and grain you now can have the right porosity for your job. Use Por-os-way on hard tool and die steels. It holds the corner and requires very little dressing. Try Por-os-way also on softer materials; copper, aluminum, wood, rubber, plastics. You'll find loading held to a minimum. Try this wheel on your own job. Write today for the booklet that "tells all" about Por-os-way and offers a "prescription" blank for the wheel best suited to your own uses. A. P. DE SANNO & SON, INC., 432 Wheatland St., PHOENIXVILLE, PENNA.

**POR-OS-WAY* *a new* RADIAC* PRODUCT**

# A LOT CAN HAPPEN IN A *few* SECONDS!




Official Photograph, U.S. Army Air Corps.

A second's warning! *Split-seconds to act* – but, that's what it takes to make a great combat pair! A ship and a pilot in perfect coordination – with every operating factor clicking in positive accord. Controls taut, sensitive, responsive – transmitting the "feel" that says, "Go to it – I'm with you!" Where else could the friction-freedom of Fafnir Ball Bearings serve so importantly?

Fafnir Aircraft Ball Bearings are assuring this responsiveness of controls on all ships of the Army and Navy Air Corps, on commercial airliners and on all R. A. F. ships built in America. Every type of plane is included . . . dive bombers, long-range bombers and patrols, fast, deadly interceptors and pursuits, and flying fortresses.

"Fafnirs on the controls" is a standard specification among the leading aircraft builders. Fafnirs mean dependability, rigidity and tightness without friction or binding – and long-life that eliminates trouble and time-wasting replacement. Catalog and data sheets are available. The Fafnir Bearing Company, Aircraft Division, New Britain, Conn.

Behind machines in the Lycoming Division plant and behind Lycoming engines in the air, men are being trained today who will contribute to America's victory tomorrow.
Lycoming-powered
BEECHCRAFT
AT-10 TRAINER

# MANPOWER . . . TRAINED BY *Lycoming*

**BUILDS America's Aircraft Engines . . . FLIES America's Fighting Planes**

Our all-out-for-victory war will be won by manpower in the factory as well as in battle. That is why at the elbow of each experienced workman in the Lycoming plant an eager youngster is busily learning the skilled craftsmanship which has made Lycoming a synonym for dependability throughout the aviation industry. This duplicate "soldier of production" will later contribute his skill to the important task of increasing the output of Lycoming engines. But that is not all . . .

In Army and Navy training centers and on hundreds of America's airports Lycoming engines now power the training planes of the nation, making fighting pilots of fledglings eager for combat. The same dependable flow of smooth, economical power so necessary for pilot instruction today will meet the exacting requirements of private plane owners in the days after victory is attained.

Free literature on request for 50 to 175 h.p. horizontally opposed or 220 to 300 h.p. radial engines. Write Dept. A52. Specify which literature desired.

*Contractors to the U. S. Army and Navy*

THE TRAINING PLANE ENGINE OF TODAY . . . THE PRIVATE PLANE ENGINE OF TOMORROW

LYCOMING DIVISION, THE AVIATION CORPORATION — WILLIAMSPORT, PA.

# KEEPING 'EM FLYING!

**CECO** Aircraft Products · Fuel Pumps · Hydro-Metering Carburetors · Protek-Plugs (for corrosion prevention by dehydration)

Chandler Evans Corporation

SOUTH MERIDEN, CONN.

*Manufacturers of Aircraft Carburetors, Fuel Pumps and Accessories.*

ADEL Hydraulic Control Valve—one of four basic assemblies upon which are predicated over fifty single, dual, triple, quadruple and quintuple **standardized** units.



ADEL Line Support clips and blocks,—PROVEN—70,000,000 in use on U. S. Army Air Corps, U. S. Navy, British Air Ministry and Commercial Aircraft—under every conceivable condition in all parts of the globe.



ADEL Series "J" **standardized** multi-purpose, direct drive, vane type fluid metering pump—for carburetor, propellor, windshield anti-icing protective functions.

*Tokens for Tokyo*

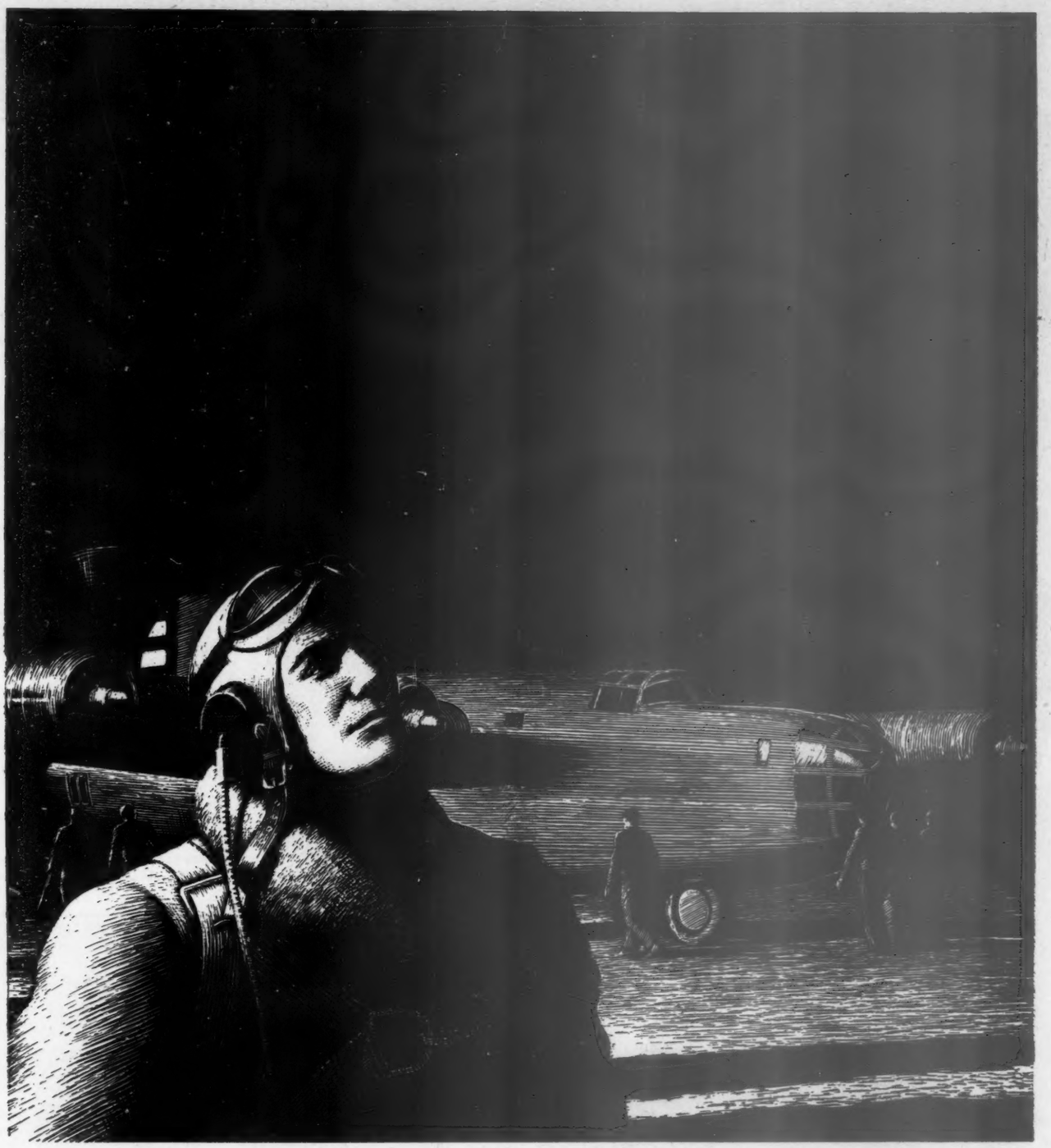
Dropt thru the aid of ADEL bomb bay door hydraulic control valves! Devastating delivery and safe return of ship and crew assured by ADEL anti-icing pumps. ADEL integrally cushioned and bonded line supports and hydraulic equipment for all functions. Every ADEL Worker is proud that more than 3,000 types and sizes of ADEL products are assisting the United Nations.

**ADEL**

**PRECISION PRODUCTS CORP.**

SOMEWHERE IN U. S. A.

Thomas, Mgr., 302



*The* **BONDS** *You Buy Will*

# KEEP 'EM FLYING

*Consolidated* *Aircraft Corporation*

SAN DIEGO · CALIFORNIA

# "which type of portable power tool will give me peak production?"

## BASIC ADVANTAGES of the Three Types of Portable Power Tools

Available for a wider variety of applications than any other type.

Generally of more rugged construction.

Cannot be damaged by overloading.

Easily stand up under the hardest kinds of heavy duty service.

Run on ordinary AC or DC electric current which is available almost everywhere.

Offer a wide range of models for all kinds of production and maintenance.

Installation costs generally lowest of all.

Lowest operating costs for users of ten or more tools.

Maintain virtually constant speed under load.

Nature of high frequency current permits simplified construction for light weight, easy handling, reduced maintenance.

● Of the three different types of portable power tools — Pneumatic . . . Universal Electric . . . and High Frequency Electric — *one* almost certainly offers decided advantages over the others for *your* particular product and operations.

Which type that is can be determined best by competent study of your particular conditions. *Thor* can give you this competent cooperation because:

*Thor* makes all three types of portable power tools.

*Thor* has the engineering "know how" that comes from building good tools for nearly fifty years.

*Thor* is working continuously to make the good tools of today even better tools tomorrow . . . to develop new tools for new applications.

*Thor* has the trained Service Engineers to put this advisory service into practical operation.

Before you tool up, get this expert, impartial advice. Plan your application of portable tools *in advance* — and get peak production! For further information, without obligation, write Independent Pneumatic Tool Company, 600 W. Jackson Blvd., Chicago, Illinois.

Thor

PORTABLE TOOLS

PNEUMATIC ● UNIVERSAL ELECTRIC ● HIGH FREQUENCY ELECTRIC

Let Thor help you get peak production with the right type of Portable Power Tools

●

# WHICH TAP SHALL I USE... HIGH SPEED or CARBON ?

Just as in any other cutting operation, the right tool for the job to be done will guarantee best results. Here are a few hints that may help you in determining what type of tap best fits your needs:

### 1. Cost of Tap vs. Cost per Tapped Hole

Carbon Steel Taps cost less than High Speed Taps. If you can get equal results as to quality of thread from either type, then by all means use Carbon Taps.

Even though the quality of threads produced is equal, however, you may find that High Speed Taps will tap more holes at less cost per hole.

### 2. Operating Conditions

Ordinarily, High Speed Steel Taps must be run at higher speeds than Carbon Steel Taps, usually 2 to 2½ times as fast. If your tapping machines or screw machines haven't the speed necessary for efficient operation of High Speed Taps, the use of carbon taps may be advisable.

Consult a cutting speed table covering suggested speeds for various tap sizes and materials.

### 3. Material Being Tapped

The physical properties of the material being tapped will, many times, leave you no choice as to type of tap to use; some materials *require* the use of High Speed Taps while others may be tapped equally well or even better with Carbon Taps. For example, Carbon Steel Taps are efficient in brass and ferrous metals while most non-ferrous metals and abrasive materials, such as bakelite, fiber, hard rubber, etc., quickly turn cutting edges and indicate the use of High Speed Taps.

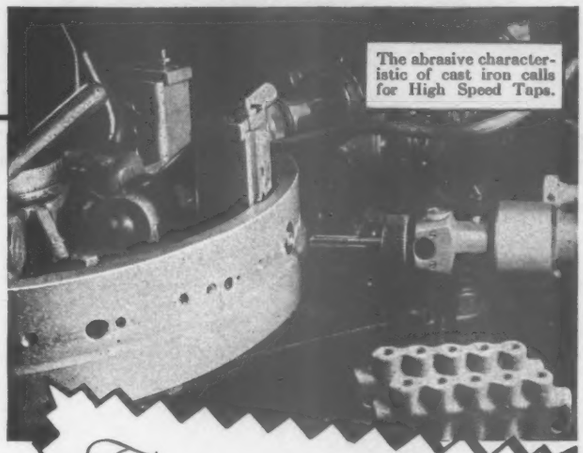
### 4. Results Required

Precision Threading, requiring the close tolerances obtainable only with Ground Thread Taps, will ordinarily dictate the use of High Speed Taps, since only High Speed Taps are regularly furnished with Ground Threads.

---

There is a tendency today to use High Speed Steel Cut Thread Taps when Carbon Steel Taps would serve the purpose just as well. Check your tapping jobs to be sure that you are using the correct type of tap for each.

Similarly, don't specify GROUND THREAD Taps if CUT THREAD Taps will do.



The abrasive characteristic of cast iron calls for High Speed Taps.

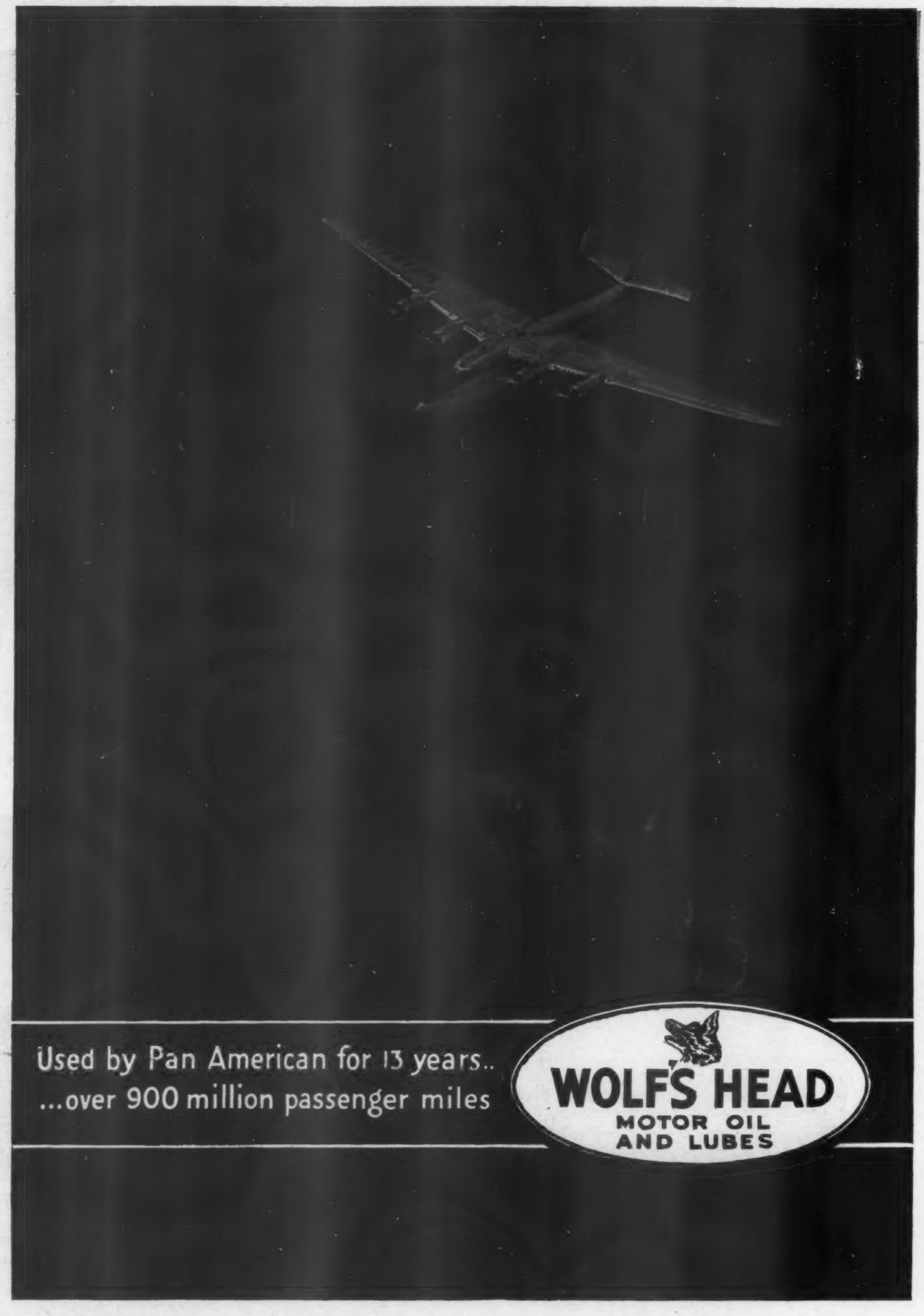
*This is one of a series of advertisements published by the Greenfield Tap and Die Corporation to help users get greater production from their taps. The entire series is now available in booklet form. Send for a copy.*

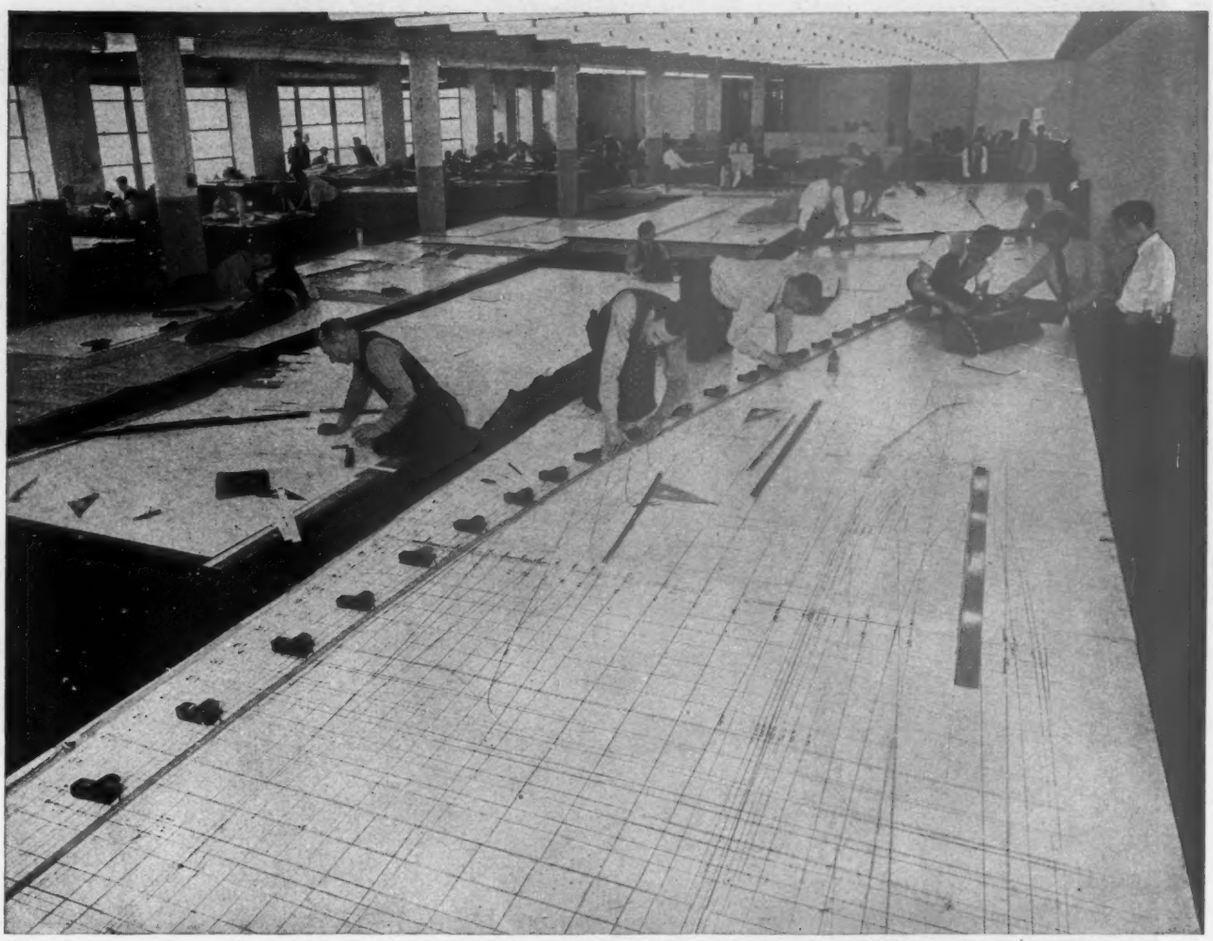
Carbon Taps are efficient in brass.

**GREENFIELD TAP AND DIE CORPORATION**
GREENFIELD • MASSACHUSETTS
DETROIT PLANT: 2102 West Fort St.
WAREHOUSES in New York, Chicago and Los Angeles
In Canada:
GREENFIELD TAP AND DIE CORP. OF CANADA, LTD., GALT, ONTARIO

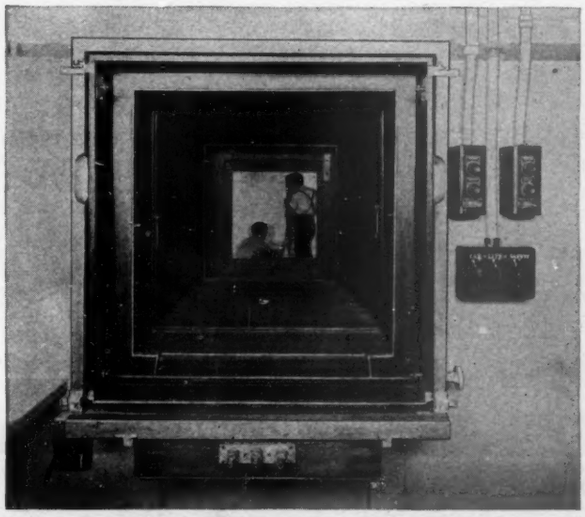
GTD GREENFIELD

TAPS · DIES · GAGES · TWIST DRILLS · REAMERS · SCREW PLATES · PIPE TOOLS


Used by Pan American for 13 years..
...over 900 million passenger miles
WOLF'S HEAD
MOTOR OIL
AND LUBES



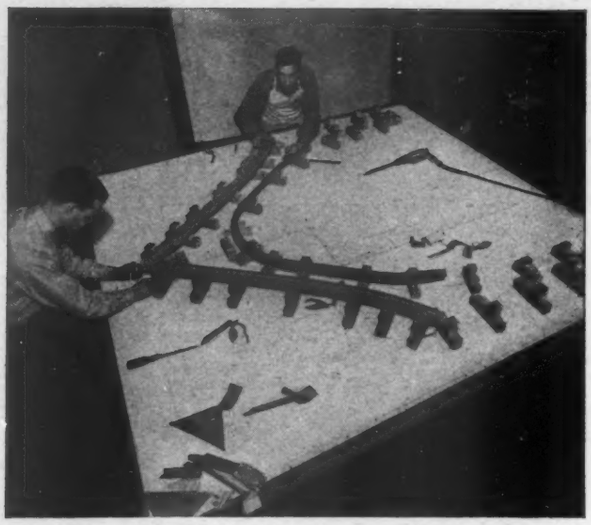
***Martin Aircraft*** are first laid-out full scale in the mold-loft. From these accurate dimensions all details are designed—also at full scale—on metal sheets. Then Martin's giant camera reproduces these original drawings on other metal sheets, or on cloth, paper, glass, plastics or wood, for use where needed.



***Camera Corridor:*** This view, through the bellows of the new Martin photo process camera, gives some idea of its vast size. Believed to be the world's largest camera, it takes up every inch of two big rooms, can reproduce drawings up to 5 by 10 feet.

***Check!*** Martin inspectors check limited-number parts directly against photo-layout. With quantity parts, inspection gauges may be cut directly from lines photographed on the surface of the metal, then fitted against other parts for rapid and exact operation.

*Like Tin-Types* of another day, plans are printed directly onto bare metal. Using jig-saw methods, workmen turn out experimental or small-quantity parts with practically no tolerance of error.



*Jig Time* is reduced by photo-layout. Jigs, along with other parts or fixtures, are built onto full-scale photo-layouts. This eliminates measuring and checking necessary in working from small-scale drawings.

# 750,000 Man-Hours Saved Annually by Each Martin Robot Draftsman

☆

FIRST and most successful application of photography to the reproduction of drawings is the Martin Photographic Reproduction Process. Using colossal cameras, original engineering drawings are photographed in any scale and the images projected back directly onto sensitized surfaces of metal, wood, cloth, paper, glass or nearly any other material.

"Drafting by camera" thus has released literally hundreds of engineers from routine work and placed them on more important assignments. Drafting itself is simplified (complicated plans can be duplicated in less than five minutes); corrections expedited. Shop and experimental work are speeded. Toolmaking is improved. Inspection is aided.

The Martin-originated photo-drafting process has already made its impact felt upon American industry. Many aircraft and other industrial concerns have adopted the technique . . . answering in large measure the shortage of engineering personnel.

★ ★ ★

*Photo-reproduction is just one of the many new methods by which Martin is saving man-hours and increasing production in the all-out drive for Victory.*

The Glenn L. Martin Co., Baltimore, Md., U. S. A.

Martin
AIRCRAFT

*Builders of Dependable Aircraft Since 1909*

# Yes, we eat our own Cooking!

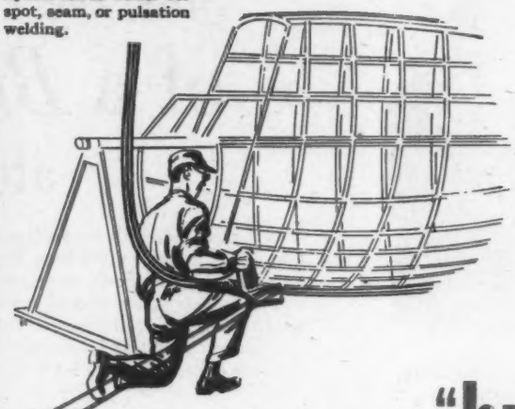
Here's a **HECKER**-designed fixture at work in our own production plant. It's helping to machine a vital airplane part for one of Uncle Sam's biggest plane-builders. Hundreds of other **HECKER** tools, jigs and fixtures are similarly at work, or "on file" in our tool cribs.

The **HECKER** tool engineer who designed this fixture knows machine tools, and understands the men that run them. He "tailor-made" the fixture to fit the part, and with an eye on the machine as well. That's why it produces at top speed, makes the job easy for the operator, yet leaves nothing to his judgment.

**HECKER** skill in design, backed by the down-to-earth experience we get from using our own products, offers a service that's hard to beat. For a single jig or a complete tooling-up job, call on A. W. Hecker, 1978 East 66th Street, Cleveland, Ohio.

A·W·
HECKER
DESIGNERS AND BUILDERS OF TOOLS, JIGS AND FIXTURES · · · FABRICATORS OF AIRCRAFT PARTS

Timer illustrated is a Type SX Combination Synchronous Timer for spot, seam, or pulsation welding.



# NO MORE "burned" OR "cold" SHORT-TIME WELDS WITH

## Westinghouse Synchronous Timers

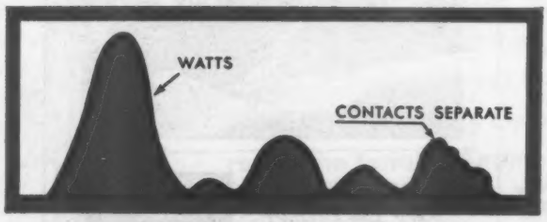
## FOR SPOT, SEAM OR PULSATION WELDING

Where welding time of a few cycles only is required for critical metals and small parts, random (nonsynchronous) switching seriously affects the quality of the weld. This is because initial surge currents can cause as much as 50% variation in the heat produced in a weld—producing either a warped, burned, or weak, cold weld.

Westinghouse Synchronous Timers eliminate unpredictable "transients" or current surges by always starting and stopping the weld current at the zero point on the current wave, or later (when heat control is used). As a result, each weld duplicates the quality of the preceding one because the wave form is the same.

These timers make possible a rigorous system of quality control that insures consistent welding of critical alloys and thin materials. Stainless steel, for example, can be welded without loss of stainless properties. Discoloration and electrode "pick-up" can be reduced. Investigate the possibilities of Westinghouse Electronic Control for your resistance welders. Ask your Westinghouse Representative for Booklet B-3102. Or write Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N. J-21223

**SYNCHRONOUS TIMING**
Starting and stopping at zero point produce even wave form—uniform "heat".




**NONSYNCHRONOUS TIMING**
Random (nonsynchronous) switching may produce this wave form—unpredictable "heat".

# Westinghouse

## RESISTANCE WELDING CONTROL

# "Son, I've Seen the Blueprints of a *Brighter World* ahead for You"

**CAPTAIN W. FLETCHER GRABILL,** veteran T. W. A. "Million Mile" pilot, and operations officer for T. W. A.'s Army Reserve Squadron in Kansas City, talks of the future to his son Wilson, who has flown over 30,000 miles.

"I SAW them building army planes for Uncle Sam when I was in Wichita. And the way they're turning them out over there makes you feel mighty good. Our aircraft builders are certainly doing their full share to help America win this war. And they'll be doing just as good a job to help make America a better place to live in when the war is over. For instance, the Cessna Aircraft Company have plans for a Family Car of the Air that's as simple and safe to fly as driving your automobile is now.

"They won't start building this new Cessna Family Car of the Air until this war's over. But when they do, it's going to open up a whole new world of opportunity for your generation. Until they showed me those Cessna blueprints, I hadn't believed much of this talk about people flying their own planes. But I'm certainly convinced now that you'll be travelling all over America in your own Cessna Family Car of the Air as soon as this war is over. And so will everyone else."

***You'll Call It Your Family Car of the Air...*** because you'll learn to fly it as quickly as you'd learn to drive a car. It will be every bit as easy and as safe, only you'll be covering three times the distance, cruising comfortably and naturally along the skyways instead of the highways. And every one of those skyways will be planned and regulated for civilian air traffic as carefully as they are controlled for the airlines now.

It's only natural that Cessna with its 31 year background in aviation should have developed the airplane that everyone can buy and fly. It was an aviation problem that could be answered only by men who have spent their lives developing such aircraft as the Airmaster, three times judged the World's Most Efficient Airplane. And that answer is in the future Cessna, ready to be produced for you as soon as this war is over.

## *All Out* for Victory Now!

Our job today is a 24-hour effort to keep twin-engined Cessnas flying regularly to the U. S. Army Air Corps and the Royal Canadian Air Force. In the past 12 months Cessnas have flown over 50 million miles in bomber training service. Deliveries are well ahead of schedule. And they're going to stay ahead. That's our only job until this war is won.

***Wear Your Wings! Keep 'Em Flying!***

Yes, wear these *wings-with-a-reason!* They'll be a handsome, permanent reminder that you're helping to "Keep 'Em Flying." Send 10¢ (coin or stamps) to Cessna Aircraft Company, Wichita, Kansas. We'll send you a 10¢ Defense Stamp in return...and enclose your wings free, postage paid.

**Cessna** SYMBOL OF **Aircraftsmanship**
FOR THIRTY ONE YEARS

# LANDING FIELD 60×60!

## WHERE AEROL STRUTS PROVE THEY CAN TAKE IT

*A Typical Aerol Main Leg Strut*

***All-out inspection for all-out efficiency.*** **Guided by that principle, Cleveland Pneumatic uses the world's largest drop test equipment to check the strength and energy capacity of Aerol Struts. Located in a laboratory only sixty feet long by sixty feet wide, this equipment can accurately duplicate the terrific impact that occurs in landing even the *mightiest* bomber. For it can produce a gross weight of impact up to 300,000 pounds, which is far in excess of the load factor of any plane ever built. ★ Testing Aerol Struts on this equipment results in three important advantages—adequate strength, complete safety, and faster production. It proves that the struts are strong enough to meet the exacting specifications of the airplane manufacturer. It assures the pilot that his plane will land safely, no matter how large the ship or how rough the terrain. Furthermore, by reducing the testing time to only five minutes, it speeds production—a vital factor, because America's Victory Program has created a tremendous demand for Aerol Struts. ★ Outstanding inspection methods, such as this unique drop test equipment, is one of the reasons why Aerol Struts are overwhelmingly preferred by the aviation industry *to keep 'em landing, safely and smoothly!***

**THE CLEVELAND PNEUMATIC TOOL CO.**

Marble Ave. & East 77th St. · Aircraft Division · Cleveland, Ohio

CONTRACTORS TO THE UNITED STATES GOVERNMENT

# With telling effect

## THEY MEET EVERY CHALLENGE

Wherever and whenever they go into action, American aircraft demonstrate the telling effect of their power . . . the result of precision manufacturing and craftsmanship.

Among the factors that provide efficiency is the seating for pilot, gunner, radio operator and observer. Comfort and freedom to make quick decisions are the objectives of officials and engineers who design this seating, and from these designs skilled GF craftsmen carry to completion the important job of building what is needed to make seating an integral part of all-over efficiency . . . to meet every challenge in the air.

**THE GENERAL FIREPROOFING COMPANY**

YOUNGSTOWN • OHIO

# Time is the most critical material!

## TIME CAN'T BE BOUGHT BUT IT CAN BE SAVED

Surging through thousands of shops and plants there's an unbeatable determination to win Victory, and win it in shortest possible time. • TIME!—that's the vital element. Even fractions of minutes are precious. Seconds lost by one machine, multiplied by many machines, result in wasted days and weeks—even months. Such time waste is a dangerous enemy at our door. • Consider procedures in production and you'll find that operations revolve around *paper work routines.* In effect, they help to control production, and this control can either *SAVE* time or *WASTE* time. • To *simplify* and *organize* paper work routines . . . to *decrease* non-productive time, *prevent* costly mistakes and *diminish* expensive wastes . . . to *facilitate* accuracy in determining costs . . . these are the functions of Addressograph-Multigraph methods.

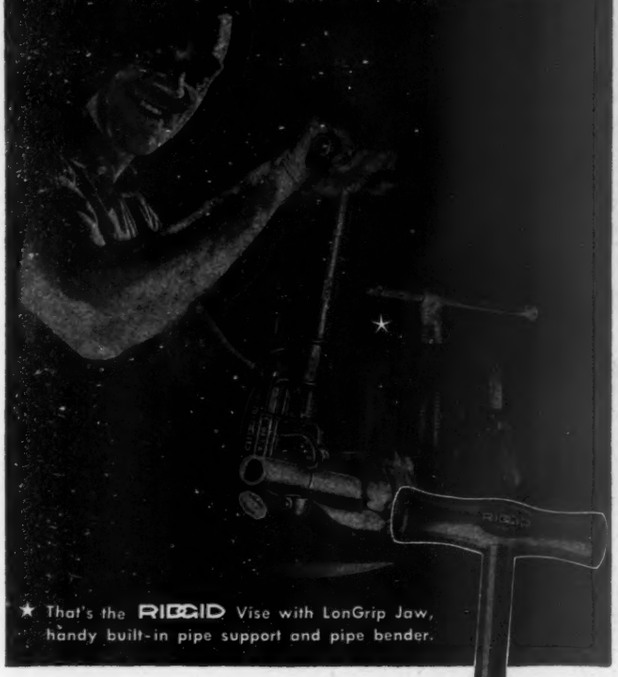
*USERS OF OUR PRODUCTS are entitled to the services of our Methods Department. It can help to extend the use of their equipment in Purchasing, Storeskeeping, Production, Marketing, Shipping, Billing, Collecting, Disbursing and all key operations of business. To those who are interested in up-to-date information on better methods it is available on request, without charge.*

**ADDRESSOGRAPH-MULTIGRAPH CORPORATION** • *Cleveland* • *Ohio*

(A poster enlargement of above, free of advertising and suitable for bulletin board or framing, will be sent free on request.)

Addressograph-Multigraph Methods SAVE BRAIN HOURS AND HAND HOURS

# You Lick Delays with this Speedy RIDGID Pipe Cutter



★ That's the RIDGID Vise with LonGrip Jaw, handy built-in pipe support and pipe bender.

# You can thread it *Faster* with this work-saver RIDGID No.11R

AMERICA'S most serious shortage today is shortage of Time...save every minute of this priceless essential to winning the War. Save some of it with this speedy RIDGID threader for small pipe (to 1¼"). Instant changes of size: push one die head out easily, quickly, snap another in — it can't fall out. You don't have to bother with special dies for close-to-wall threads — simply reverse regular dies; they're tool steel, come out easily for regrinding, cut clean perfect threads. Conduit dies if you want and handy carriers with full sets — no extra cost. A rugged steel and malleable tool — ask to see it at your Supply House.

There's no time these days for slow tools — in construction, production or maintenance, no speed is good enough... Well, you cut *more* pipe with *less* effort with this RIDGID. Special thin cutting wheels, forged and assembled in solid hubs, roll easily and cleanly through any pipe, save reaming time. Heavy-duty malleable frames that stand overwork, always cut true. Made 3-wheel and 4-wheel (No. 42) for still speedier cutting. Four sizes, for pipe to 4". Don't tolerate even small delays—buy time-and-work-saver RIDGIDs at your Supply House.

RIDGID *Thin Forged Cutter Wheel*

**All RIDGID Pipe Tools are sold only through Supply Houses**

RIDGID

THE RIDGE TOOL COMPANY
ELYRIA, OHIO, U.S.A.

**Pipe Wrenches, Cutters, Threaders, Vises**

**Work-Saver Tools for America's Big Job in 1942**

# Lightning Strikes

Hard-striking, fast-striking Lightning...a wizard of high-altitude maneuverability ...the Lockheed *Lightning* is a tough-sinewed interceptor, a ship built to reach new sky ceilings—and stay there to take and give plenty of fight.

It is a 'plane made to stop enemy bombers ...dive or long range, high or low altitude... before they get to their objectives.

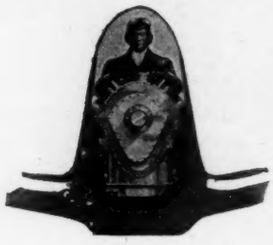
Built, too, as a fighting guard for our own bombers, it is a 'plane to sweep enemy skies as well as our own, teaming up with other hard-fighting American-built aircraft flying for the United Nations to win air supremacy to win this war.

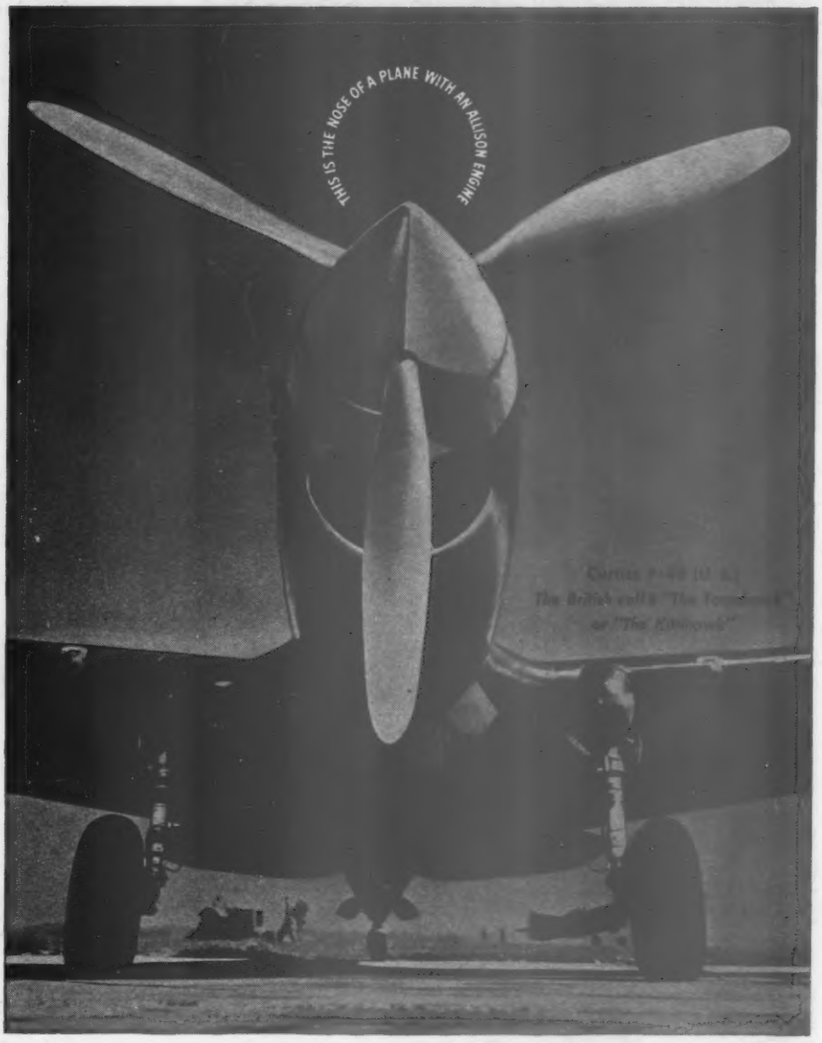
**... for Protection today and Progress tomorrow**

## LOOK TO *Lockheed* FOR LEADERSHIP

*Lockheed Aircraft Corporation • Burbank, California*

# "No broader than a Pilot's Shoulders"






THAT'S an important specification for an airplane engine, when you want every mile of speed you can get from a military fighter plane.

When you cut down wind-resistance, you get more good from horsepower and fuel, because it's less effort to push the plane through the air.

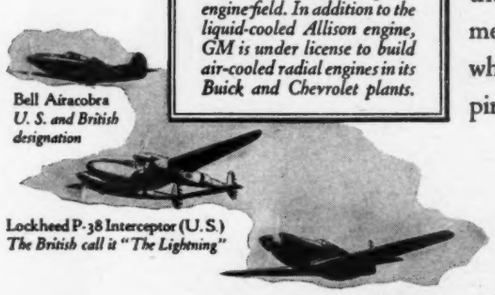
And only with a liquid-cooled engine can you build such a plane.

So General Motors undertook the long job of developing the Allison engine—starting back in 1930.

And now that thousands of these engines have gone into service, America can be glad that someone tackled that job. They're going into planes for the U.S. Army and the R.A.F. And they've been meeting the test of combat everywhere — in Hawaii, the Philippines, Europe, Africa, the Middle East and along the Burma Road.

Each succeeding month, in fact, adds to the evidence that the Allison engine is unsurpassed for the job assigned to it.

*The experience of General Motors is full-rounded and without bias in the airplane engine field. In addition to the liquid-cooled Allison engine, GM is under license to build air-cooled radial engines in its Buick and Chevrolet plants.*



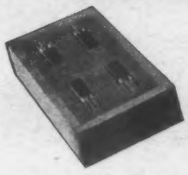
Bell Airacobra
*U. S. and British designation*

Lockheed P-38 Interceptor (U. S.)
*The British call it "The Lightning"*

North American Apache (U. S.)
*The British call it "The Mustang"*

LIQUID-COOLED AIRCRAFT ENGINES **Allison** DIVISION OF GM GENERAL MOTORS

The object of most physical tests made on materials, equipment, and structures is to determine the magnitude, kind, and number of stresses—the amount of resistance a member or structure offers to loading, twisting, vibration, or distortion under specific conditions. Some of the many types of strain gages and auxiliary equipment needed in stress determination are the following:



**RECORDING SCRATCH AND METALECTRIC STRAIN GAGES**

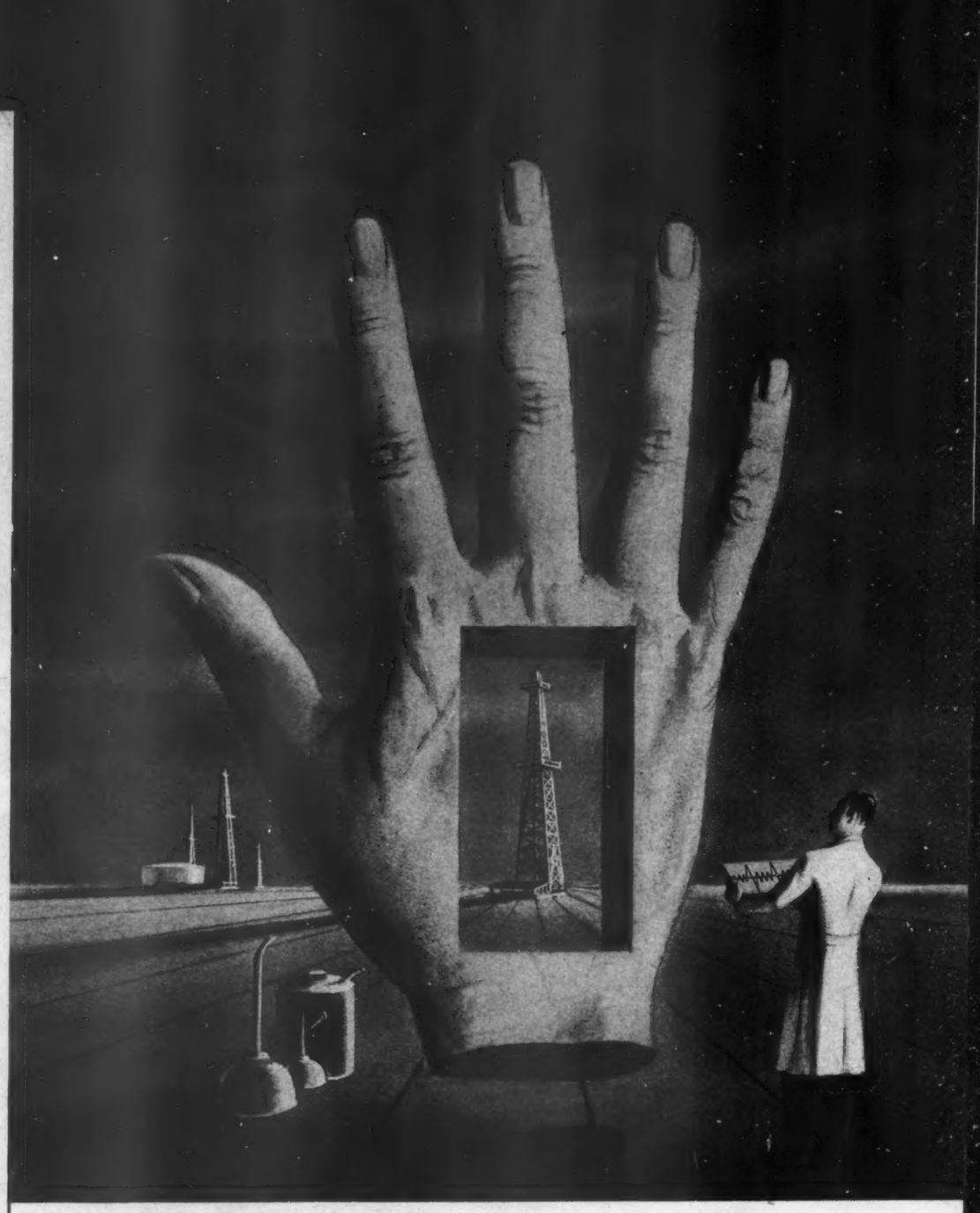
are representative of the mechanical and electrical types of gages. Both gages are light-weight, simple, inexpensive, and reliable. The field of usefulness of these gages is almost unlimited. *Auxiliaries:* scratch gages, microscope for reading records, control box for static loads, amplifiers and recorders for dynamic loads.

**SLOW DYNAMIC CONTROL EQUIPMENT AND CALIBRATOR**

Designed for use with electric and magnetic strain gages, static and slowly applied loads. Calibrator for instantaneous checking during dynamic testing of resistance type strain gages.

* * *

*Other auxiliary testing equipment in this group:* Spring and motor driven scratch gages; inductor telemeter; Stresscoat, a brittle lacquer for aid in stress analysis; microscope and viewing equipment.



# He measures stresses through a seeing hand

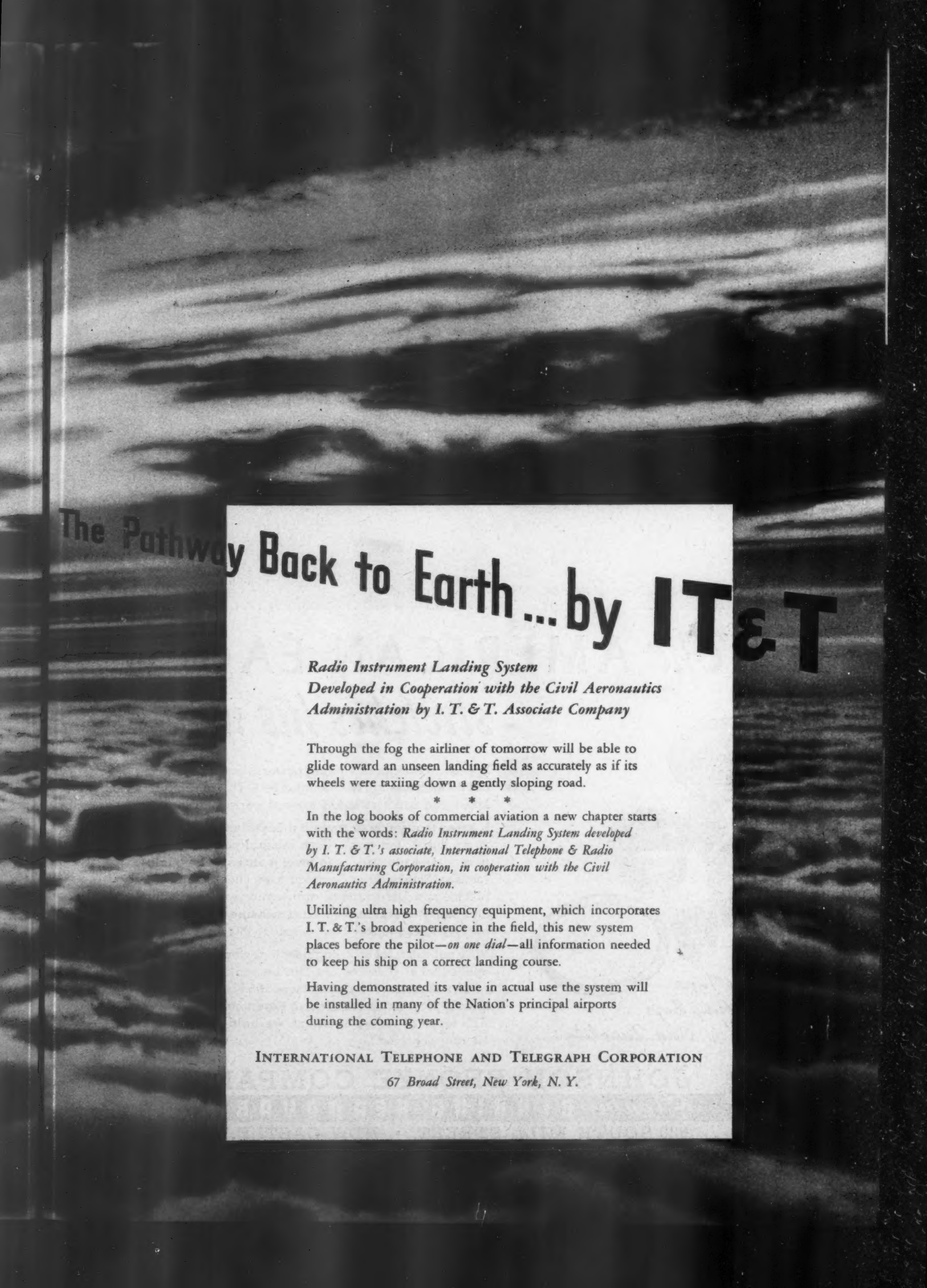
In the oil industry, as in every commercial field today, avoidable breakdowns can no longer be tolerated. Overnight, expert *pre-testing* of equipment has become a national "must".

It was for this precise purpose that WAUGH LABORATORIES was formed . . . to make available a complete line of dependable test instruments and machines, together with an experienced engineering field staff and laboratory facilities, for the determination and analysis of strains, forces, and vibrations in and on structures of all kinds.

For information regarding its services as applied to individual industries, write to Nereus H. Roy, *Director,* at the address below.

**WAUGH** *Laboratories*

A DIVISION OF WAUGH EQUIPMENT COMPANY • 420 LEXINGTON AVENUE, NEW YORK, N. Y.
Pacific Coast Branch: 714 West Olympic Blvd., Los Angeles, California



# The Pathway Back to Earth ... by IT&T

***Radio Instrument Landing System***
***Developed in Cooperation with the Civil Aeronautics Administration by I. T. & T. Associate Company***

Through the fog the airliner of tomorrow will be able to glide toward an unseen landing field as accurately as if its wheels were taxiing down a gently sloping road.

* * *

In the log books of commercial aviation a new chapter starts with the words: *Radio Instrument Landing System developed by I. T. & T.'s associate, International Telephone & Radio Manufacturing Corporation, in cooperation with the Civil Aeronautics Administration.*

Utilizing ultra high frequency equipment, which incorporates I. T. & T.'s broad experience in the field, this new system places before the pilot—*on one dial*—all information needed to keep his ship on a correct landing course.

Having demonstrated its value in actual use the system will be installed in many of the Nation's principal airports during the coming year.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

*67 Broad Street, New York, N. Y.*

# *The* AMERICAN EAGLE *stretches his wings*

*Any Type*
*Any Size*
*Any Quantity*

Speed...tremendous striking power...long range flying are all embodied in this Douglas B-19. This is America's latest and greatest stride toward aerial supremacy.

It takes thousands of small but important parts to construct this 82 ton giant. Each integral part is designed to do a specific job . . . to meet a standard of quality. Johnson Sleeve Type Bearings meet the accurate and precise specifications in applications of this nature. Our policy of building an extra measure of service into every bearing makes them ideal for this vital role.

Why not ask a Johnson engineer to review your bearing applications? Chances are that he can make a worthwhile suggestion . . . a recommendation backed by more than 30 years exclusive bearing experience. As we make *ALL* types of sleeve bearings, we hold no prejudice for any one kind.

The most complete SLEEVE BEARING SERVICE in the world

**JOHNSON BRONZE COMPANY**

*Sleeve* BEARING HEADQUARTERS

620 SOUTH MILL STREET • NEW CASTLE, PA.

*The B.F. Goodrich Airplane of the month*

# CONSOLIDATED B-24

**High, wide and handsome** is a perfect description of Consolidated Aircraft's famous B-24 Bomber. Because this huge 4-motored plane is capable of reaching great altitudes —carrying tremendous bomb-loads—and is a handsome performer in every way!

The B-24's take-offs and landings are made on B. F. Goodrich Airplane Silvertown Tires. It accomplishes safe, smooth braking, thanks to B. F. Goodrich E. T. Brakes. The leading edges of its great wings are guarded against icing by B. F. Goodrich De-Icers . . . its fuel supply is protected by our Self-Sealing Fuel Tanks.

Consolidated's B-24 is our choice for Plane of the Month.

*The Army flies with*
B.F.Goodrich
FIRST IN RUBBER

# B.F. GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*

## NEW RUBBER FEED SHOE FOR PROPELLERS GREATLY INCREASES PROTECTION AGAINST ICE

THE GOAL of modern aircraft has been to fly higher, faster, more efficiently, and this has led to larger propellers, lower RPM. Because of this, pouring *anti-freeze* fluid on the inner end of the blades will not carry it far enough out on the leading edges of a propeller to afford sufficient protection. To overcome this problem, B. F. Goodrich recently developed the propeller anti-freeze feed shoe, which is affixed, by the Goodrich Vulcalock process, to the leading edge of a propeller blade.

The B. F. Goodrich propeller feed shoe is a carefully designed tapering strip of rubber. It is cemented, as mentioned, to the leading edge of the propeller blades. At the wide end, which fits directly under the feed pipe from the slinger ring, are several small grooves. These grooves pick up the anti-freeze fluid as it is spilled and carry it the full length of the shoe. The base grooves, as they run toward the tip, merge into a single groove, so designed that just the right amount of fluid is conveyed and just the right amount overflows. Thus the propeller edge is constantly bathed in the protective fluid.

Years of painstaking research have gone into the design of this shoe. One major airline with a serious year-round icing problem adopted this product as standard equipment as soon as it was introduced commercially. At present *four* major airlines are using it on all planes.

The advantages of this shoe, other than the fact that it permits a plane to fly safely through more severe icing conditions than heretofore, are: 1) Reducing of propeller vibrations by keeping ice off; 2) reducing the amount of alcohol a plane must carry; 3) preventing damage to sides of a plane by removing ice in smaller pieces; 4) preventing sand abrasion and water erosion on the leading edges of a propeller.

For information, write B. F. Goodrich, Aeronautical Div., Akron, Ohio.

**MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES**

# *A quick picture of*

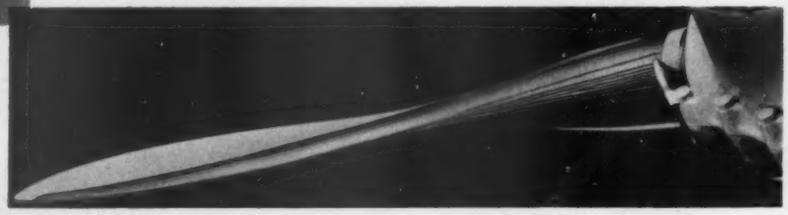
# RUBBER FEED SHOE INSTALLATIONS

**THE LATEST TYPE** of B. F. Goodrich propeller anti-freeze feed shoe, as it is now used by Trans-Canada Air Lines. Note the slinger ring and hose connection to the feed ring.

★ ★ ★

**A TYPICAL PROPELLER** feed shoe installation, without the feed ring, is shown in picture at right.

**THE ARRANGEMENT** of the grooves at the blade root of the B. F. Goodrich propeller feed shoe is designed to convey the fluid along the leading edge.



**THE FLOW PATTERN** of the anti-freeze fluid is demonstrated on the cambered face of this propeller blade. In order to photograph, the fluid was colored and a test flight made. It will be seen that the fluid is distributed over the entire blade-face.

*In war or peace*

**B.F.Goodrich**

**FIRST IN RUBBER**

# THIS POWER TOOL INCREASES SPEED OF "BLIND RIVET" INSTALLATION 400%

Speeding up aircraft production with rivets that can be headed and upset from one side is the job that B. F. Goodrich Rivnuts are now doing for manufacturers and maintenance crews everywhere! This "blind" rivet is made of a highly corrosive-resistant aluminum alloy. A new power tool developed by the Chicago Pneumatic Tool Company in cooperation with B. F. Goodrich engineers speeds installation by over 400%. Wherever a "blind" rivet is called for, use B. F. Goodrich Rivnuts.

## B. F. GOODRICH SILVERTOWN TUBES

B. F. Goodrich Silvertown Airplane Tubes have high tensile strength, and are designed to resist tearing and provide maximum elasticity with minimum of loss. They are made of a special heat-resisting compound.

## B. F. GOODRICH SILVERTOWN TAIL WHEEL TIRES

**B. F. Goodrich** pneumatic tail wheel tires are designed to withstand the terrific shocks and the sudden twisting strains placed upon them in all types of landings.

A complete line of tread designs is available, corresponding to the tread designs that are built into the tires used on landing wheels.

Solid rubber tail wheels are also available. They are cured into a heat-treated aluminum alloy hub, which is recessed to accommodate the solid rubber; they come already equipped with bearings. Also—a special Zero Pressure tire is made with a cavity that helps to cushion landing-shock.

B. F. GOODRICH · AERONAUTICAL DIVISION · AKRON, OHIO

# Trained Men vs. MATERIALS

*Aviation has JOBS for thousands, but CAREERS only for trained men!*

The finest of material is necessary for the aircraft industry's tremendous effort to fulfill President Roosevelt's inspiring demand for 185,000 warplanes, but inanimate material—no matter how essential—is useless without the skill to mould it into the finished plane. While it has been necessary for the industry to accept thousands of single-phase workers from cheap "quickie" courses, these men are scarcely more than another class of material, which must be moulded and directed by those properly trained to occupy responsible supervisory positions. The career man with long-range training is the most essential single unit in aviation's war production . . . and ONLY he will continue to be essential through the readjustments that must follow when America's production shifts back to peace time schedules.

The executives who have made aviation THEIR career know that the value of each man is governed by two factors: his intelligent sincerity in selecting aviation as his life work, and THE ABILITY AND EXPERIENCE OF THOSE WHO TRAIN HIM FOR THAT CAREER. They know that Curtiss-Wright Technical Institute graduates are—and for many years have been—thoroughly qualified to fill the industry's exacting requirements.

Located in the very center and a very important part of Southern California's great aircraft industry, with its more than two billion dollars in unfilled orders, Curtiss-Wright Tec has come to be recognized as the nation's leading institution for the training of Aeronautical Engineers and Master Mechanics. Mr. Donald Douglas, President of the great Douglas Aircraft Company, chose this school for his own son's training, which pointedly indicates the high standing Curtiss-Wright Tec has attained in the aircraft industry since its establishment in 1929.

It is imperative that before you invest in a course of career training you determine what the returns will be on your investment . . . for your choice of a school in which to take your training will determine how much money you will make all the rest of your life.

Curtiss-Wright Tec's career training is carefully designed to do just one thing:—TO MAKE MONEY FOR YOU, so upon graduation you can be independent and self-supporting for life. Our thousands of successful graduates have proven that Curtiss-Wright Tec training gets results and always pays, since it trained them in advance for the highest position they could ever expect to occupy. It can do the same for you.

This school has never guaranteed positions for its graduates, but practically every graduate has obtained immediate employment and is advancing rapidly. The demand for our graduates far exceeds the supply, and we honestly believe that every student who enrolls here will be able to obtain, with our assistance, immediate employment upon graduation.

WARNING!—"Don't miss the boat." The greatest opportunity in your lifetime exists today! There never was such an opportunity in aviation for you: and there may never be another. A position awaits you. Insure for yourself a steady income and independence for life. DON'T FOLLOW—LEAD! Send in your enrollment before you "miss the boat."

THIS TOWER OVERLOOKS AVIATION'S MOST DISTINGUISHED SCHOOL OF AERONAUTICS

OFFERING SPECIALIZED AND PROVEN TRAINING IN

★ *Aeronautical Engineering and Master Mechanics* ★

**CURTISS WRIGHT TECHNICAL INSTITUTE**

GRAND CENTRAL AIR TERMINAL 1226 AIRWAY GLENDALE (LOS ANGELES) CALIF

UNDER PERSONAL SUPERVISION OF MAJOR C. C. MOSELEY, OWNER, SINCE ITS ESTABLISHMENT IN 1929

*Contractor to the U. S. Army Air Corps*

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- ☐ SPECIALIZED AIRCRAFT SHEET METAL COURSE
- ☐ AERONAUTICAL DRAFTING COURSE, HOME STUDY
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# On the "ROUTE OF THE FLAGSHIPS"

## Wright Cyclone engines use dependable SHELL

Model of this Wright Cyclone-powered Douglas courtesy of American Airlines.

Over American Airline "skyroads" wing Douglas Flagships, their mighty Wright Engines using Shell Aviation Fuel for unfailing power, instant throttle response, on-the-dot schedules.

Airline operators, scores of plane and engine manufacturers, too, testify to the dependable performance, not only of Shell Aviation Fuels, but AeroShell Oils as well; in transports, light planes, fighters, pursuits and bombers.

**This growing preference is one of the best reasons we know for progressive airport operators to stock Shell Aviation Products.** Investigate! Write: Shell Oil Company, Inc., 50 West 50th St., New York, N. Y., or 100 Bush Street, San Francisco, Cal.

SHELL

**AVIATION FUELS • AEROSHELL OILS**

# MEET THE MEN WHO WEAR THIS BADGE

EMERSON-ELECTRIC

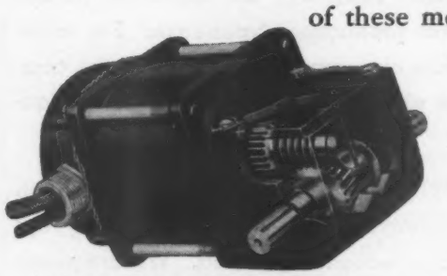
EMPLOYEE

## Builders of Emerson-Electric Motors

SKILLED manpower working with precision equipment has been responsible for the fine reputation established for Emerson-Electric motors.

Time and time again, during the past half-century, Emerson-Electric Designers, Engineers and Workers have been called upon to tackle tough assignments. And, today, the skill and experience of these men are developing and producing precision-built electric motors for airplane gun turrets, hydraulic units, fuel pumps and tab controls; also with built-in gear reduction and limit stop.

Whatever your electric motor requirements may be, you are invited to take advantage of Emerson-Electric's coordinated experience and precision-production facilities. Engineers thoroughly familiar with aviation's problems are available for consultation.



SPECIFIC APPLICATION

*Emerson-Electric Motor drive for Airplane Gun Turret Ammunition Booster. Output Shaft speed 100 r.p.m.; Torque, 160 ounce feet; Weight 3½ lbs.*

THE EMERSON ELECTRIC MANUFACTURING CO.
ST. LOUIS • *Branches:* New York • Detroit • Chicago

EMERSON ELECTRIC ELECTRIC

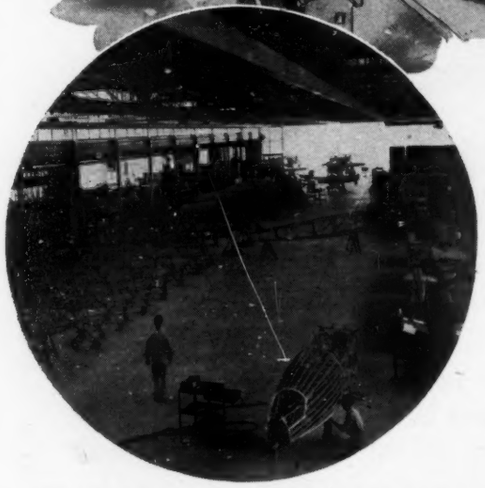
253

5 H. P. and Smaller **ELECTRIC MOTORS FOR AIRCRAFT** 5 H. P. and Smaller

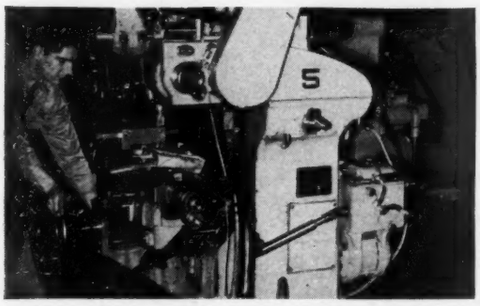
# SPARTAN

## Will Fly the Peaceful Skyways of Tomorrow

### ...AFTER TODAY'S WAR PRODUCTION JOB IS DONE



*(Above)* Vital training planes are rolling off the Spartan assembly line.



*(Above)* Spartan machines as well as Spartan men are busy for defense.

THE SPARTAN AIRCRAFT COMPANY is meeting today's challenge with every ounce of effort, every resource at its command. As contractor to the U. S. Army and the U. S. Navy, SPARTAN considers its "all out" war production as an opportunity to perform a national duty.

But after war comes peace . . . Victory and peace . . . and a need for new and finer civilian and commercial aircraft.

Then again will trim, smart, speedy SPARTAN airplanes fly the sky lanes of America. They will be improved planes developed from today's war production experience. For while we here at SPARTAN devote our complete facilities to the common task that confronts us all, we are looking ahead . . . planning ahead.

The SPARTAN "EXECUTIVE" established a great reputation for dependability and maneuverability—as a luxuriously appointed all-metal cabin plane reasonably priced. We are proud of that reputation, but are determined to outmatch it with the SPARTAN airplanes of the future.

# SPARTAN

## AIRCRAFT COMPANY

*Contractor to the U. S. Army and the U. S. Navy*

TULSA, OKLAHOMA

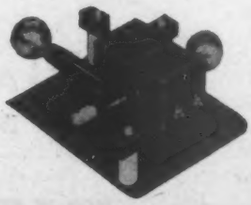
**SPARTAN SCHOOL OF AERONAUTICS,** a division of the Spartan Aircraft Company, is Government Approved and industry-recognized as one of the outstanding aviation schools in America. Hundreds of skillfully trained Spartan School graduates are now employed in the Spartan Factory. Hundreds of others are located in every type of position throughout the aviation industry—which continues to look to Spartan School for additional aircraft workers.

CAPABLE of handling an R. F. potential of 20,000 volts at 30,000 feet altitude—yet no larger than your hand is the new Model 3926D Bendix Vacuum Relay which takes the place of cumbersome heavy equipment for switching antenna circuits and other relay applications.

Unparalleled reliability already has been demonstrated by the relay in thousands of installations and the new model is even more efficient.

The Bendix Relay consists of single pole double throw switch enclosed within a highly evacuated, nonex glass envelope. This makes the unit entirely independent of climatic conditions, altitude, dirt or oxidation. The arm, or armature, when actuated by an external electro-magnet, transfers the circuit from receiver to transmitter. Because of the small mass of the armature and the small space between contacts the transfer allows instantaneous break-in. This speed of action enables keying at 40 words a minute. The spacing between the open contacts is approximately .015", yet because of the high vacuum this space is ample to stop transfer of energy between the open contacts.

Weight of the 24-volt unit, including case, is 24-ounces. The relay measures 2 5/8" x 5 5/8" x 6 7/16" overall. Coils can be supplied for any common voltage. Bendix invites inquiries regarding requirements for circuit applications or special installation problems.



BENDIX *North Hollywood*

SUBSIDIARY OF BENDIX AVIATION CORPORATION

INTERPHONE SYSTEMS • TRANSMITTERS • COMMUNICATION UNITS • RANGE FILTERS • CONTROL PANELS • JACK BOXES • ANTENNA SWITCHES • MICROPHONES

VACUUM SWITCHES • FABRICATION OF ELECTRICAL CABLES • INTERFERENCE FILTERS • INSTALLATION ENGINEERING • HYDRAULIC AIRCRAFT UNITS

# The Birdmen's Perch

**This month's Perch is being written in an unnamed town, somewhere east of the Mississippi. We've not been recognized yet and if we can help it we're not going to be! Our Tattered Wing Tips are positively lacey at this point. Explanation below.**

**Major Al Williams, alias "Tattered Wing Tips,"**
**Gulf Aviation Products Manager, Gulf Bldg., Pittsburgh, Pa.**

## A GOOD FIVE-CENT SAGA

First time we have a chance we're going to sit down and write one of those jump-ahead-of-the-Gestapo books. It'll be a daisy, too. We have become a one-man persecuted minority.

For the benefit of the three (there couldn't have been more) lads who did NOT write nasty things to us about our mistake in the January Perch, it happened like this: We printed a Brain Twister in which Aviators 1 and 2 asked for half of each other's gas. The boys should have said "one gallon" instead of "half."

Well, sir, soon after the Twister appeared we began to get requests for the

answer. We mailed them out, chuckling like crazy at how we'd stumped all the smart Perch Pilots.

Then ZOWIE!—the mail began to zing into Pittsburgh in fighting vees. "Where did we ever get an answer like that; and who ever told us the puzzle *could* be worked; and what was the country coming to with such people as us on the loose?"

We checked back, found our mistake, pinned a letter of apology to our door for the mailman and got out of town fast!

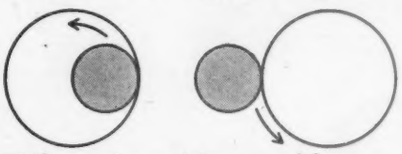
Wherever we go now, dogs snarl at us, children throw stones. No one will talk to us—not even our draft board. But worst of all is our treatment at the hands of flying men. We've skulked from one end of the country to the other trying to hide from pilots who leer at us and hiss, "STUPORMAN!"

*Please, fellas, give us another chance.*

If you do, we'll give you a lulu of a puzzle this month. We'll give you a puzzle that'll throw you into a flat spin in thirty seconds flat. (Anti-spinchutes barred.)

## THIS MONTH'S BRAIN TWISTER

The diameter of the large gear is just twice that of the small one. How many revs will the small gear make in going round (A) the inside of the large gear (B) the outside of the large gear?



Ya' better give up right now and drop us a card for the answer. Our solution has been triple tested, double checked, and passed by a board of experts—this month!

## CENTIGRADE STUFF

A late model, twin-engine attack bomber has two 13-inch oil coolers which do the cooling job of an *18-ton refrigeration system!*

Mention that to someone outside of aeronautics and he'll probably tell you you're crazy. Tell it to a man in the industry and he'll simply shrug his shoulders and wait for you to continue.

We're trying to point out that superlatives have become commonplace in this business. We continually take for granted things which astonish non-flying men. Such as Gulfpride Oil—

Try explaining to one of your groundling friends the temperatures and speeds

under which Gulfpride must deliver an efficient job of lubrication.

Tell him that even though we used nothing but the finest crudes available, we had to develop a special refining technique, the Alchlor Process, to make a lube with Gulfpride's stamina. Make him understand that this Alchlor Process begins where ordinary refining methods leave off. It does a more *complete* job of purifying; gets *more* of the carbon makers and sludge formers out of Gulfpride. Tell him Gulfpride Oil costs about the same as other aviation lubricants.

Then grab your non-flying friend by the arm—he's apt to be sagging a little.

• • •

We're going to pass up the Whopper this month and see if we can't track down some of the Perch Pilots we've not heard from lately.

We wonder, for instance, if Mush Mathis is still a jump ahead of his CPTP classes and how E. H. Pickering's business (air freight) is, these days.

We've not heard from the Swinson brothers who operate a flying service in Pratt, Neb.,

nor from Dave Mayor, in many moons. And what about Foggy Davidson? If you fellows are out of ink, maybe a drop or two of Gulf Aviation Gas might help your pens take off.

Ground Instructor Walter Biddle was in Albuquerque when we last heard from him, but that was months ago. And Bob Secrist of Dayton and Richard Sullivan of Kansas City, what's happened to you lads?

Come on, gang, let us know what's happening. And send in some more Whoppers and Brain Twisters.

And *don't* forget the answers.

MAJOR AL WILLIAMS

**Gulf Oil Corporation and Gulf Refining Company . . . makers of**

GULF AVIATION PRODUCTS

**OIL IS AMMUNITION** **USE IT WISELY !**

MASS PRODUCTION

BENDIX AVIATION LTD.

# CHECK VALVES

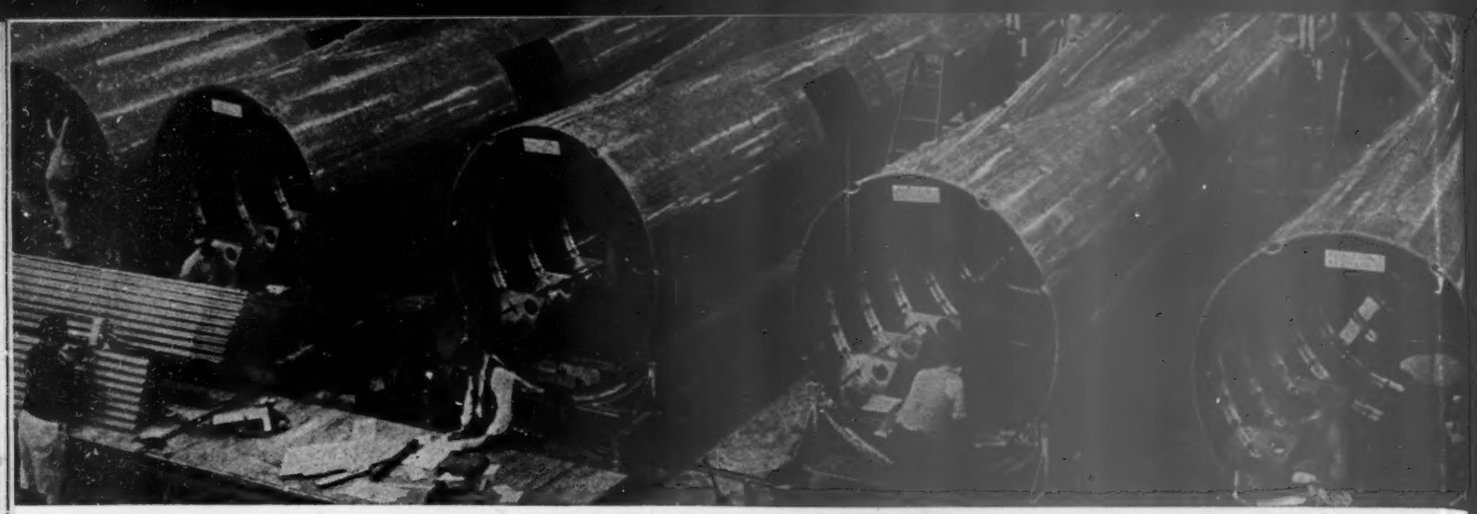
BENDIX AVIATION, Ltd., is supplying its Hydraulic Check Valves — on schedule — for eighteen different Air Corps and Navy Airplanes — *and production can be immediately increased to meet additional requirements.*

Simplicity of design, less weight, extreme long life and ease of manufacture are important features of the Bendix Check Valve which are responsible for the skyrocketing use of this equipment.

Bendix Check Valves incorporate an exclusive Plastic Poppet which *wears in,* instead of wearing out. The poppet seats directly in the valve body, eliminating the use of inserted seats. All sizes of Bendix Check Valves from 1/4" to 1" are available. Threaded ends meet both AC specification 27993 and AND-10056.

BENDIX AVIATION North Hollywood

SUBSIDIARY OF BENDIX AVIATION CORPORATION



# July AVIATION — War Production Number

## TO HELP THE MEN WHO ARE BUILDING THE 185,000 FIGHTING PLANES CALLED FOR BY THE PRESIDENT

*Production miracles are being performed in America's fastest-growing industry. New methods, new techniques, new tools, new machinery are being developed almost daily. AVIATION, the business magazine of the industry, brings to the builders of America's giant Air Force an authoritative exchange of the latest production advancements. In July the Annual Production Number of AVIATION will present an up-to-the-minute round-up of all phases of major production methods . . . THE WAR PRODUCTION NUMBER OF AVIATION.*

**Editorial Highlights that present the story of *"How Mass-production Methods are being applied to Aviation Production"***

HOW THE AIRCRAFT ENGINE INDUSTRY HAS STEPPED UP PRODUCTION MANY TIMES OVER in 18 short months. A case presentation of mass-production methods that will help many another manufacturer.

HOW ONE OF OUR INDUSTRIAL GIANTS IS GEARING UP TO MASS-PRODUCE FIGHTER POWER-PLANTS. An informative discussion of tool-up procedure and installation of machinery to achieve quantity output.

AIRFRAME ASSEMBLY PRODUCTION. How aviation and automotive engineers collaborated to produce new fabrication methods to push production to a new high.

MASS-PRODUCING ONE OF THE WORLD'S FASTEST FIGHTERS. How tolerances are kept down to a forty-millionth of an inch, production quality control, the education of subcontractors in production methods.

HIGH DEGREE OF PRODUCTION EFFICIENCY is achieved in many plants by breaking airframes down into sub-assemblies providing maximum working space at all stages of assembly. This article will include an "exploded view" of an important warplane with the description of its mechanized assembly line.

PRODUCTION CONTROL MIRACLE. How a brilliantly conceived engineering release system on cards translates intricate blueprint data into assembly records with incredible speed and accuracy.

FIRST COMPLETE ACCOUNT OF A REVOLUTIONARY NEW FORMING-BY-DRAWING PROCESS for sheet steel, magnesium sheets, stainless steels, aluminum alloys, etc., used in aircraft production.

HOW SUBSTITUTE MATERIALS ARE OPENING UP BOTTLE-NECKS. How new developments in plywoods, fabrics, synthetics and steels are helping to speed production.

THE WAR PRODUCTION NUMBER OF AVIATION will brim with a wealth of how-to-do-it information on research, design, engineering, operation and maintenance. Editorial and advertising pages will present timely, useful, practical material on new practices, improvements, speed methods, shortcuts.

**ADVERTISING FORMS CLOSE JUNE 8th**
**COLOR FORMS JUNE 5th**

**Aviation Magazine ★ A McGraw-Hill Publication ★ 330 West 42nd Street, New York, N. Y.**

# GIFT TO THE ARMY AIR CORPS

NEW YORK HERAL

*A Gift of Aircraft Workers to the Army Air Forces*

*Left to right are Robert A. Lovett, Assistant Secretary of War for Air; Lieutenant Colonel Richard T. Coiner, executive officer, Office of the Assistant Secretary of War, and Ralph S. Damon, president of the Republic Aviation Corporation, at the Republic plant in Farmingdale, L. I., yesterday inspecting a P-47 Thunderbolt high-altitude fighter which was built on their own time by workers at the factory for presentation to the government*

Drennan

## Republic Workers Give Air Corps Fighter Plane

### Contribute Time; Company Supplies Materials Free

*Special to the Herald Tribune*

FARMINGDALE, L. I., March 31.—A Republic P-47 Thunderbolt fighting plane was presented to the Army Air Corps today by the employees of the Republic Aviation Corporation, in ceremonies here a month [illegible]

work on the plane, and the company and several sub-contractors donated the material.

The plane, named "Lucky Seven," rolled off the assembly line today and was accepted for the Army Air Corps by Robert A. Lovett, Assistant Secretary of War for Arthur Strickland, of Hunt[illegible] one of the workers, was c[illegible] lot to make the presen[illegible]

In a [illegible] the [illegible]

## *Men of Republic Aviation Join in Donating a P-47 Thunderbolt to the U. S. Air Forces*

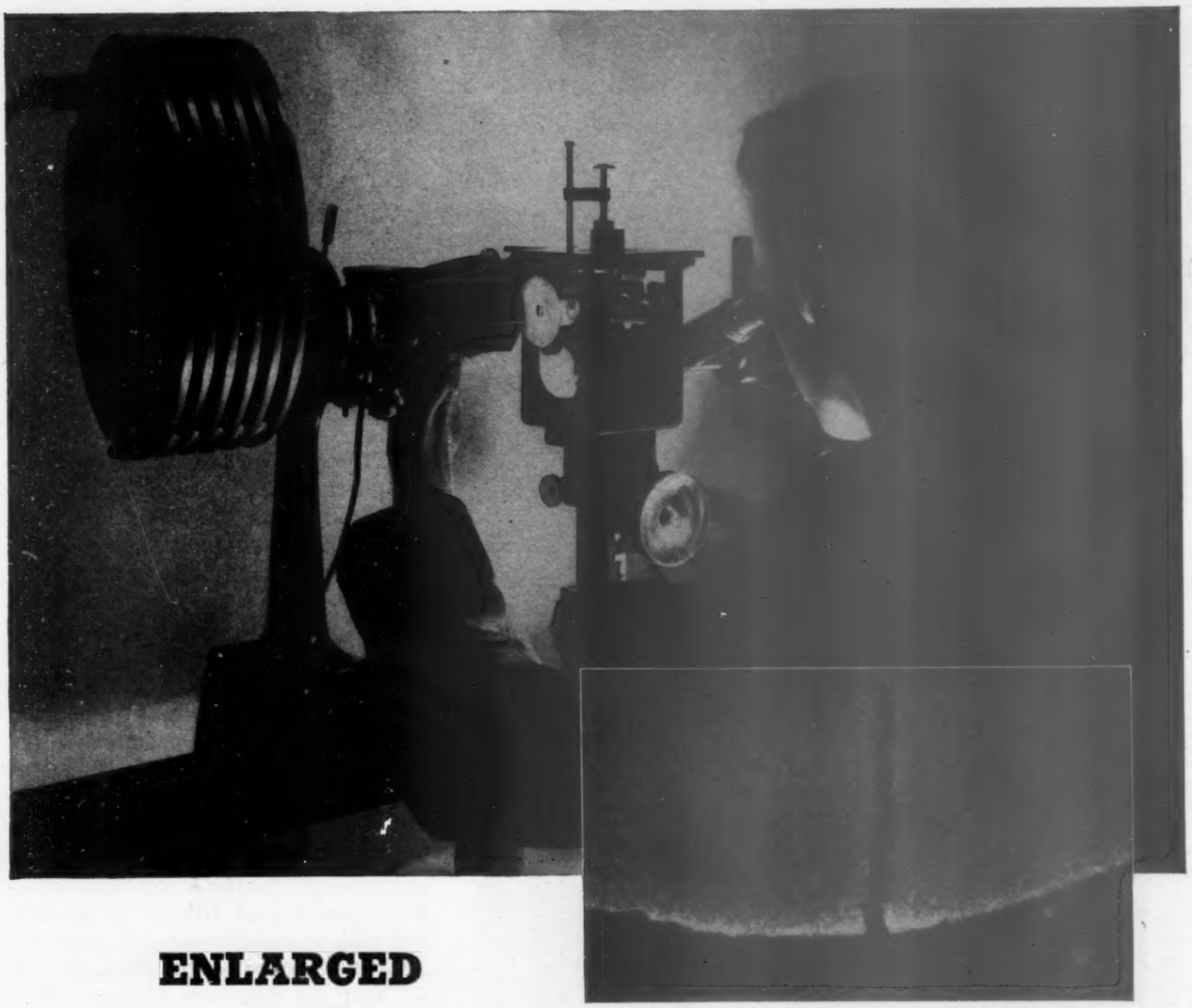
"LET'S *give* Uncle Sam a P-47 Thunderbolt . . . We'll contribute our work to help pay for the plane." That was the proposition put recently by the men to the management of Republic Aviation. In jig time the "deal" was made and Republic's gift plane, affectionately named "*Lucky Seven*," took form with record speed. On March 31st "*Lucky Seven*," completed entirely on their own time by the members of the Republic Aviation organization, was presented to Assistant Secretary of War Robert A. Lovett, for the Air Forces.

In addressing his Republic audience as spokesman for the Army fliers, Secretary Lovett paid tribute to the fine unity which exists between the men who fight and the men who produce. He said —"You are members of our team." That spirit of comradeship has always imbued the men of Republic Aviation. To them, on this appropriate occasion, we are proud to acknowledge grateful appreciation.

Republic Aviation Corporation, Farmingdale, Long Island, New York.

**REPUBLIC AVIATION**

REPUBLIC AVIATION



# ENLARGED 3,000 TIMES TO PREVENT SPRING FAILURE

Spring material must be as near perfect as possible. That's why Muehlhausen engineers use the Metallograph, illustrated above—to detect minute flaws.

Wire used in the Muehlhausen plant must undergo this test. A section of wire is mounted in a plastic mold and then polished. This specimen mount is placed in the Metallograph and photographed under high magnification. The developed print reveals the slightest interior fissure or surface crack.

This is only one of many tests customarily made by Muehlhausen engineers to insure quality in the art of spring making. Check with Muehlhausen on the design of any type spring—compression, extension, torsion or flat—hot or cold formed.

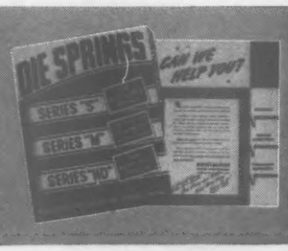
MUEHLHAUSEN SPRING CORPORATION
740 Michigan Avenue, Logansport, Indiana

MUEHLHAUSEN SPRINGS

EVERY TYPE AND SIZE

FREE! SEND FOR INFORMATION

- New Die Spring Bulletin illustrates, describes 205 sizes and types of die springs.
- New Armament Bulletin shows importance of springs for many types of war equipment.



# THIS "TRIGGER"

## THE SIMPLE PULL OF A HANDLE KILLS ENGINE FIRES FAST!

Here's finger-tip fire control for your plane! The "trigger"—a handle. The "gun"—a built-in LUX extinguishing system. The "ammunition"—a blasting cloud of carbon dioxide snow-and-gas that's sudden death to fire!

LUX gas knocks out engine blazes in a hurry. Aviation's fastest fire-killer, LUX does the job in 3 or 4 seconds. Yet LUX harms nothing but fire. This clean, dry gas evaporates into thin air, leaves no residue, causes no mess, affects neither engine nor equipment.

LUX flame detectors may be used as the actuating elements of a completely automatic fire-fighting unit. There are built-in LUX systems for both multi-motor and single motor planes, radial and "in-line" engines.

Let us send you complete information. Write for it today!

**Walter Kidde & Company, Inc., 522 West St., Bloomfield, N. J.**

THE sample poster above is an employee contribution to Beechcraft's "MacArthur Week" which was voluntarily arranged by Beechcraft shop employees to set a "par" or standard for the results of *all out production.*

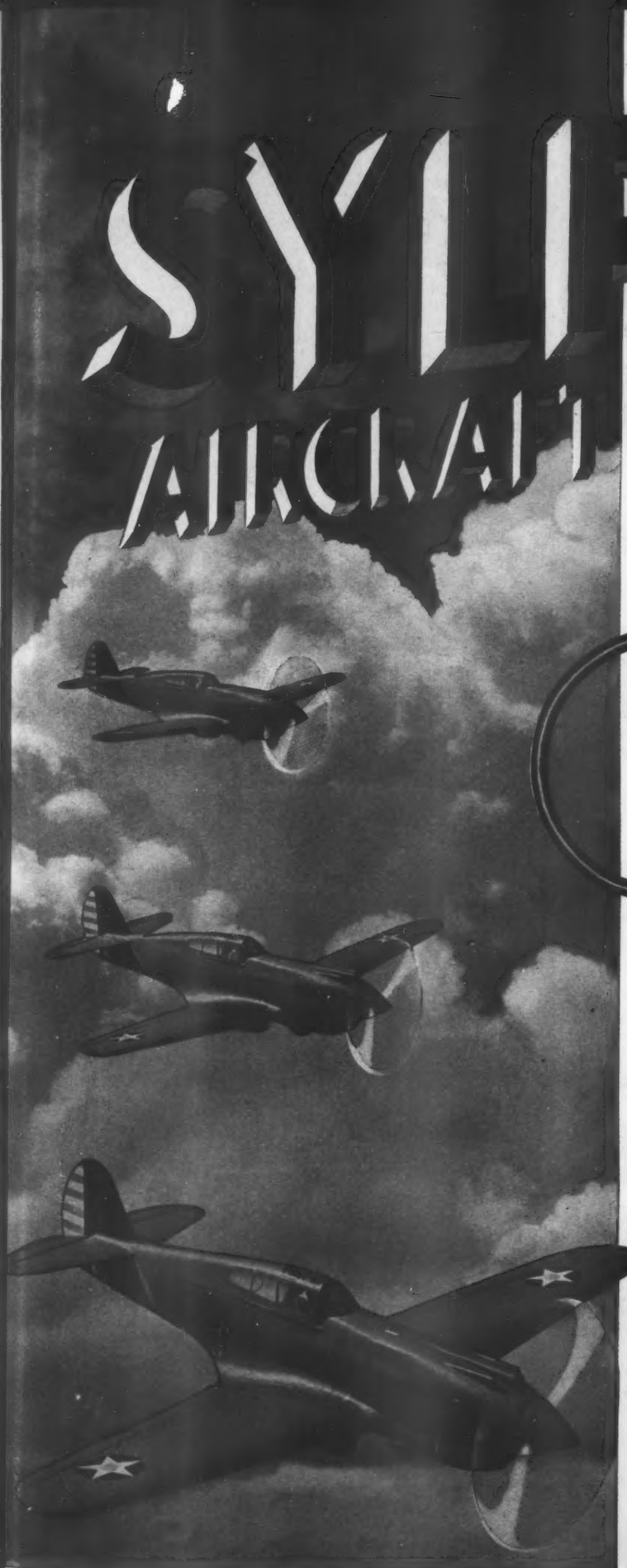
Production reached a new high for a weekly period. All employees enthusiastically participated. . . . . We offer the idea freely to those other loyal Americans who are on the production front.

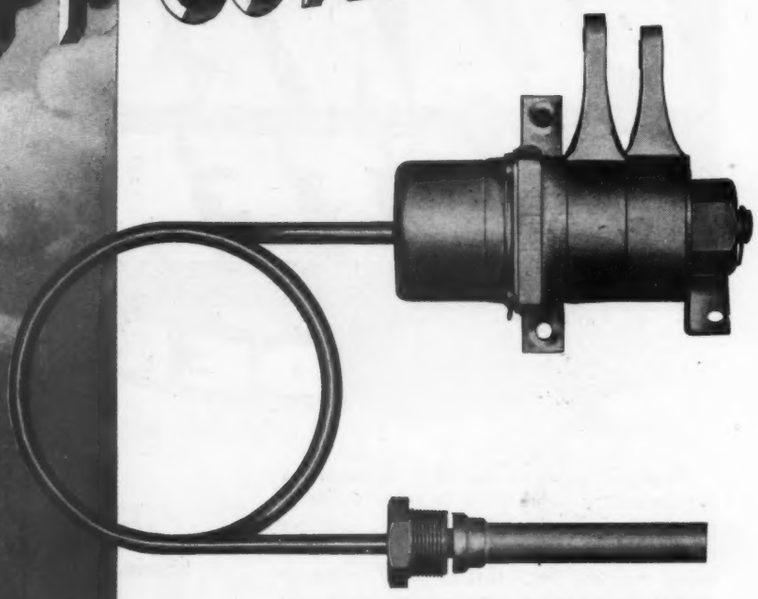
BEECH AIRCRAFT CORPORATION

Beechcraft

BEECH AIRPORT
WICHITA, KANSAS
U. S. A.

# SYLPHON AIRCRAFT CONTROLS





## THERMOSTATIC SHUTTER RELEASE

The Sylphon Thermostatic Safety Release for heat exchanger shutters is designed to cause the heat exchanger shutter to open and prevent overheating of the engine in the event the pilot neglects to open the shutter, manually, after the engine has warmed up.

Operation is as follows: The thermostatic bulb is installed in the engine jacket. Lever on left is directly connected to, the heat exchanger shutter. Lever on right is connected to the hand control. These two levers are normally locked together by a key in the control mechanism. When engine temperature exceeds a predetermined value, a Sylphon Bellows Thermostat acts to disengage this key, unlocking levers and allowing spring loaded shutter to open even though hand control remains in closed position.

When engine temperature returns to normal levers are re-engaged by returning hand control to open position.

In event of control failure levers are automatically disengaged and shutter moves to open position.

Write for Bulletin JD -822.

**THE FULTON SYLPHON CO.**

KNOXVILLE, TENNESSEE

*Representatives in All Principal Cities in U. S. A. and in Montreal, Canada and London, England*

THE NAVY "E" AWARD FOR PRODUCTION

# Building and Maintaining FASTER PLANES FASTER

DEMANDS

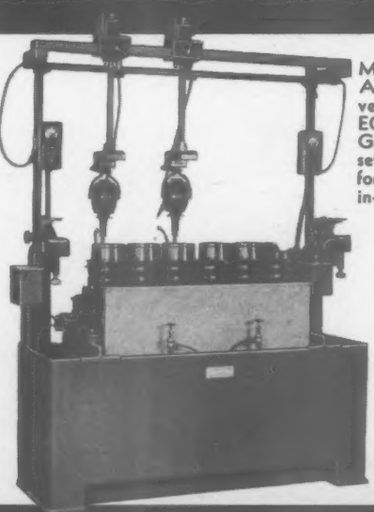
# HALL ECCENTRIC GRINDERS

A precision valve seat is as necessary as a satisfactory valve face in both airplane production and maintenance . . . Getting these high precision, fine finish seats in a hurry without time lost in slow setup or repeated gauging operations demands HALL ECCENTRIC Grinders . . . That's why Airplane Engine Manufacturers, Army and Navy air bases and Transport Companies at home and abroad have adopted HALL ECCENTRIC Grinders to provide faster planes faster.

For maintenance, users of HALL Seat Grinders have also adopted HALL Wet Type Valve Refacers for refacing airplane valves to original equipment standards of precision and finish. Dual motors, rheostat control and micrometer feed are only a few of its features.

HALL also manufactures Hones for smoothing, rounding and enlarging small diameter holes in any metal . . . This makes possible the use of dulled, nicked or under size broaching or reaming equipment for finishing to within .001" or a fraction thereof . . . These holes can be finished to size with HALL small diameter Hones by unskilled labor . . . Saves time and cuts labor, sharpening and replacement costs to a minimum; avoids delays and necessity for tying up high-production machines . . . Write today for details on the HALL equipment you need.

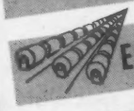
Model AW wet type ECCENTRIC Grinder used in production and maintenance.



Model AWA Universal type ECCENTRIC Grinder, set up for grinding in-line seats

THE HALL MANUFACTURING COMPANY • TOLEDO, OHIO

# HORSEPOWER for AIR POWER

WHEREVER WAR PLANES OR WAR PLANS CALL FOR SMALL MOTORS, YOU CAN COUNT ON WESTINGHOUSE TO DELIVER ON SCHEDULE . . . AND IF YOU HAVE A SPECIAL PROBLEM THAT MUST BE ANSWERED BY A SPECIAL MOTOR—WHETHER IT'S FOR A BOMB HOIST OR A FUEL PUMP WESTINGHOUSE CAN GIVE YOU PROMPT DESIGNING SERVICE WITH PERFORMANCE CHARACTERISTICS THAT CAN BE PREDICTED ACCURATELY. THE VAST EXPERIENCE GAINED FROM BUILDING THOUSANDS OF ROTATING  ELECTRICAL UNITS FOR AVIATION AND THE MANUFACTURING FACILITIES NEEDED TO BUILD THEM ARE PLEDGED TO MEET TREMENDOUSLY INCREASED DEMANDS QUICKLY . . . WITH THE FINEST PRODUCTS THE WESTINGHOUSE SMALL MOTOR DIVISION HAS EVER BUILT.

J-03166

WESTINGHOUSE

Westinghouse

SMALL MOTOR DIVISION

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, EAST PITTSBURGH, PENNSYLVANIA

# CONVERSION

## A DEPARTMENT OR A PLANT — AIDED BY

## HALLOWELL

## SHOP EQUIPMENT

***A wide selection is available to meet the usual and the unusual shop requirements.***

Fig. 928 STANDARD BENCHES

DRAWER IS EXTRA

1367 Bench combinations alone. Sturdy steel, flanged leg and stringer construction is lastingly rigid and does not become wobbly. Pyramid-type legs require no fastening to the floor, bench sets firm and steady . . . yet allows quick re-arrangement at any time. Smooth, tough tops insure a perfect working surface . . . available in laminated wood, steel or Masonite. With "Hallowell" standard construction, two or more benches can be easily joined end-to-end . . . making a continuous, smooth surface of any length desired.

### DE LUXE BENCHES

* Fig. 1728

De Luxe and Standard Foremen's Desks, Tool Cabinets and Stands . . . many with several locked drawer combinations, permitting different workers to use the one stand in multiple shift operations. Stools, Chairs and Floor Trucks.

All built to "Hallowell" rigid specifications for long life and tough service. Each designed from a wealth of practical experience to better serve the particular purpose.

Prices in line, and so are deliveries. Shop installation specialists at your service to aid in practical layout and conversion problems. Send for Catalog—check the "Hallowell" Line—first.

### STOOLS and CHAIRS

* Fig. 1249

* Fig. 1334

* Pat'd and Pat's Pending

* TRUCKS

* TOOL STANDS Fig. 705

CABINETS * Fig. 1748

## STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA. BOX 566

— BRANCHES —

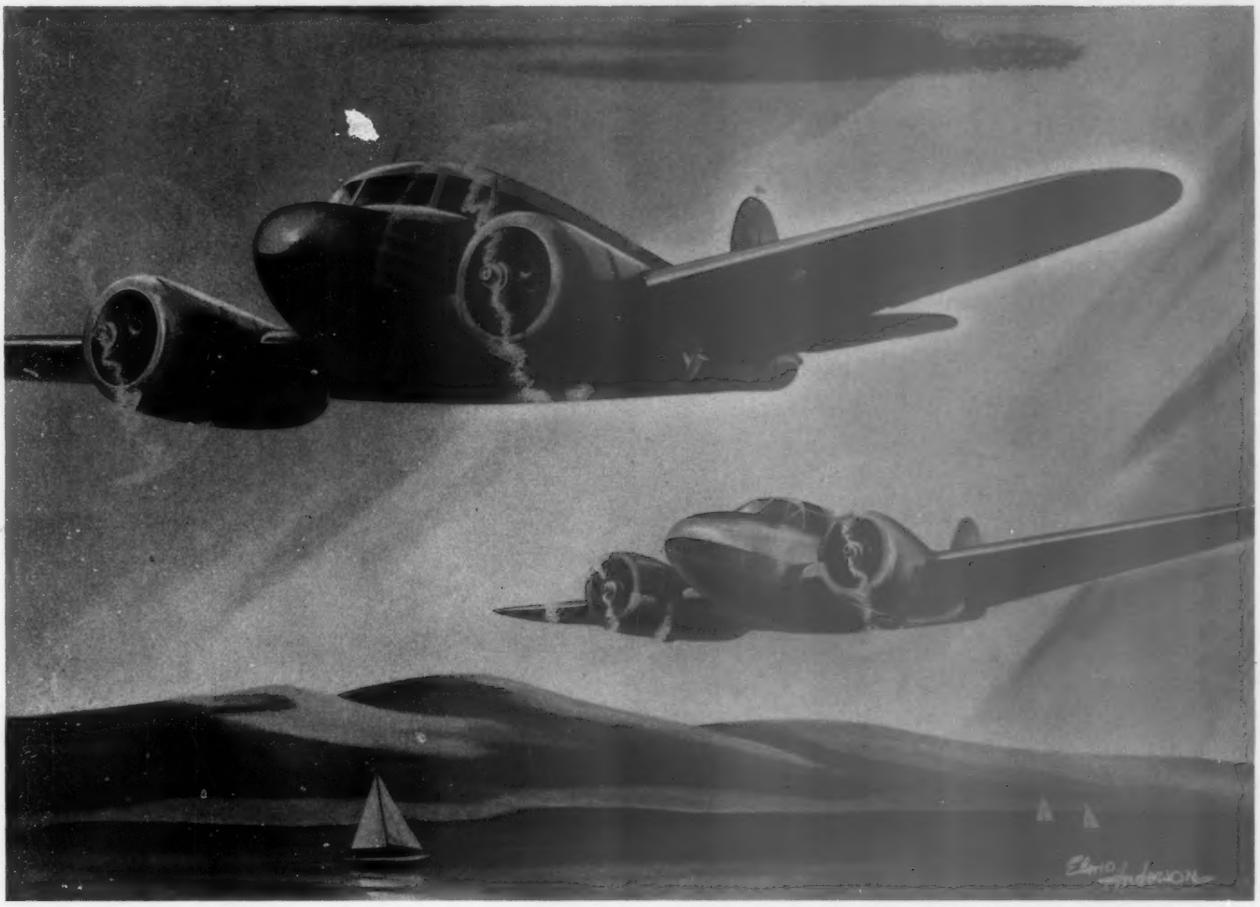
BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO

# *Air Transport—on a* Tonnage Basis

They are coming... the big ships—opening the entire world to you and the goods you make or buy. Like the largest airplanes of the past and present, they will rely on power by Wright.

**WRIGHT** *Aircraft Engines*

WILL POWER THE TONNAGE OF THE AIR



## How Boots Self-Locking "Cage" Nuts Help Build Plywood Planes

When aircraft manufacturers saw they could speed production and save vital aluminum by building trainers out of plywood and plastics, they needed a dependable self-locking nut for permanent blind fastenings. The Boots Self-Locking "Cage" Nut is getting these indispensable trainers into the air—and is enabling the substitution of plywood in certain combat plane applications.

The same Boots principle of the familiar all-metal Wing Style nut is combined with a base designed to be clinched permanently into the plywood, in spider leg fashion. It can be applied from *one side*, by *one operator* and it grips the plywood so firmly that it will withstand—without tearing—the torque applied when bolt or screw is inserted by production methods.

The application of the Boots Self-Locking "Cage" Nut for plywood will find many more applications as the use of plywood in aircraft continues in its rapid adaptation.

NEW CANAAN CONNECTICUT **BOOTS** AIRCRAFT NUT CORPORATION

Here is the Boots "Cage" nut as it comes from the factory, ready to fasten plywood sub-assemblies for faster production.

This is the special tool for fastening the nut to the plywood.

Now the nut is permanently gripping the base sheet of plywood ready to be bolted to the adjacent part of the plane.

# THE Automatic TRANSPORTER

## ELIMINATES THIS....

## GIVES YOU THIS..

*with*

★ FRONT WHEEL POWER DRIVE

★ CONTROLS IN STEERING HANDLE

★ SHOCKLESS HYDRAULIC PLATFORM LIFT WITH EASY FOOT CONTROL

● Think what this means in *safety* for your truckers—*lower* materials handling costs—and *increased* production efficiency.

WITHOUT STRAINING—TUGGING—PULLING OR EXTRA PUSHING, THE TRUCKER MERELY WALKS THE "TRANSPORTER" TO ELECTRICALLY MOVE A HEAVY OR BULKY LOAD WITH EASE AND SPEED.

The "TRANSPORTER" combines an efficient foot operated hydraulic lift system with electric power drive and is designed to serve all industry for economical lifting and transporting of various loads of raw materials and finished products on skid platforms up to 6000 lbs. This new lift truck is ideal for buildings where floor loads and elevators have limited capacity.

The "TRANSPORTER" is the latest development in lift trucks designed by AUTOMATIC engineers, incorporating many labor-aiding features derived from the knowledge gained through thirty-five years' experience in building Electric Industrial Power Trucks, Tractors and Cranes.

Streamlined in appearance—sturdy in construction—dependable and safe in operation, the "TRANSPORTER" is ready to operate at the trucker's command, forward or reverse, with complete brake and speed control. Just a few movements of the handle, a push of the button and away it goes at safe walking speed. Platform lift is just as easy with foot control. The platform lifts and lowers the load through shockless hydraulic action.

You will want to know more about this "TRANSPORTER"—how it operates and what it can do for you. Just fill in the coupon and mail—no obligation.

★ ★ ★

MANUFACTURERS FOR OVER 35 YEARS *Electric Propelled* INDUSTRIAL LIFT TRUCKS

## AUTOMATIC TRANSPORTATION COMPANY

DIV. OF THE YALE & TOWNE MFG. CO.

63 W. 87th STREET CHICAGO, ILLINOIS

**AUTOMATIC TRANSPORTATION CO.**
63 WEST 87TH ST., CHICAGO, ILL.

*Gentlemen:* Please furnish complete information on the "TRANSPORTER" without obligation.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

# PUROLATOR

## . . . *flies with this North American fighter*

● In North American Aviation's sensationally fast "Mustang"—*as in so many other leading airplanes*—Purolator filters are installed as original equipment, to protect the hydraulic system from dangerous dirt and abrasives.

★ ★ ★

**FOR HYDRAULIC CONTROL SYSTEMS** *in the 'plane*

Used as original equipment by practically all leading airplane builders, the G-159J Purolator is a thoroughly dependable filter for automatic hydraulic systems installed for the operation of wing flaps, gun turrets, retractable landing gear, and other devices. This model will handle 12 g.p.m. of 100 SSU oil at 100°F., with a maximum of 12 lbs. pressure drop. Operating pressures are up to 1500 lbs. Filtering element has a spacing of .003". Weight only 1½ lbs.

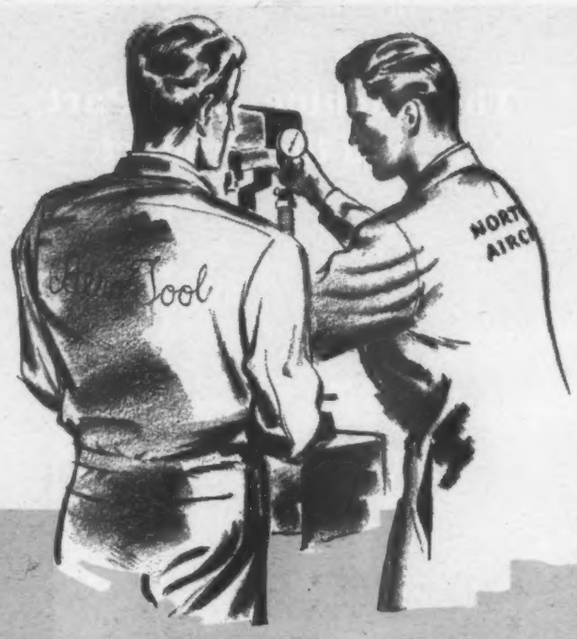
The G-160 Purolator is specially developed for use on the suction side of the hand pump in emergency manual controls. It may also be used on the discharge side of the hydraulic pump, handling 1½ g.p.m. at an operating pressure of 1500 lbs.

**FOR LUBRICATING OIL** *in the plant*

Purolator lube oil filters are now widely used to guard against the danger of dirty oil in block tests of aviation engines. Purolator meets this problem, too, with the experience gained in producing the majority of the filter equipment used on gasoline and Diesel engines of all kinds.

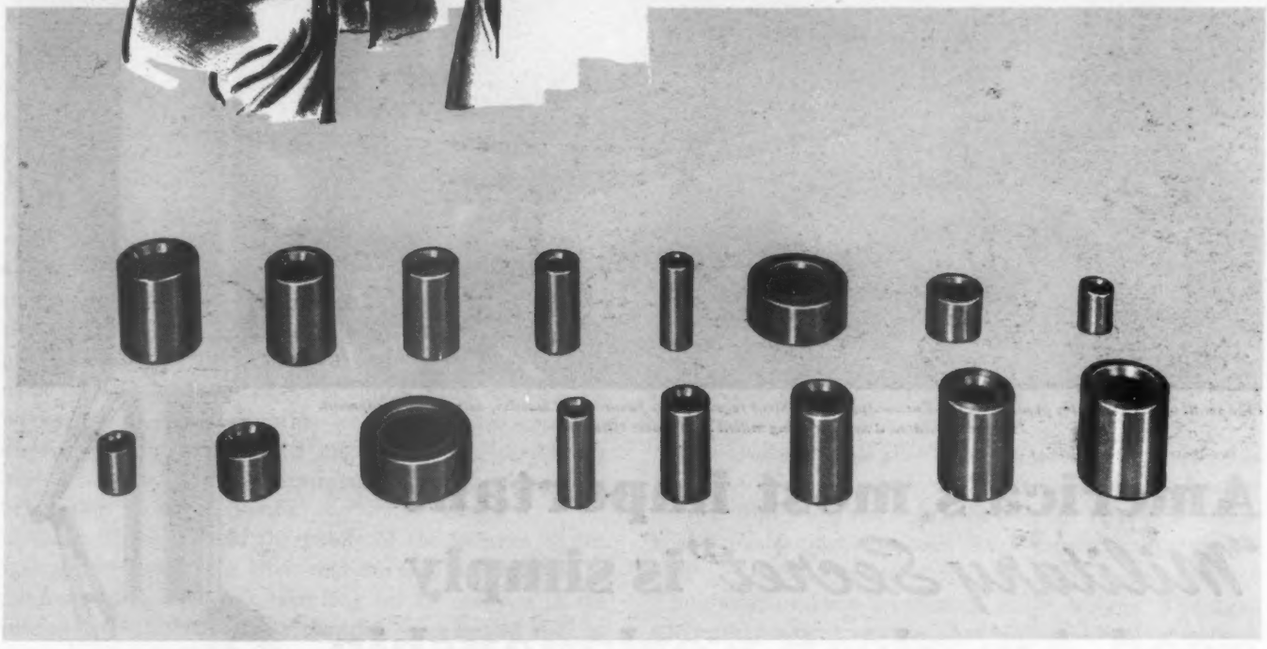
## KEEP IT CLEAN with PUROLATOR

**PUROLATOR PRODUCTS, INC.** *Home Office:* Newark, N. J.
*California Office:* 1401 South Hope Street, Los Angeles



# SHOULDER TO SHOULDER

At the drafting boards, in the tool rooms, on the production lines, the Men of Aero Tool work *shoulder-to-shoulder* with the men who make airplanes—developing *with* Aviation the tools for Aviation—*together* for Victory.



## AN EXAMPLE: Semi-Precision Drill Bushings

Long recognized as leaders and consultants in the manufacture of *extreme* precision aircraft production tools, Aero Tool now presents *Semi*-precision Drill Bushings because the need is here—they can be made *faster*—delivered *immediately* and, like all other Aero Tool products, they'll do the job *right*—and that's what Aviation demands today.

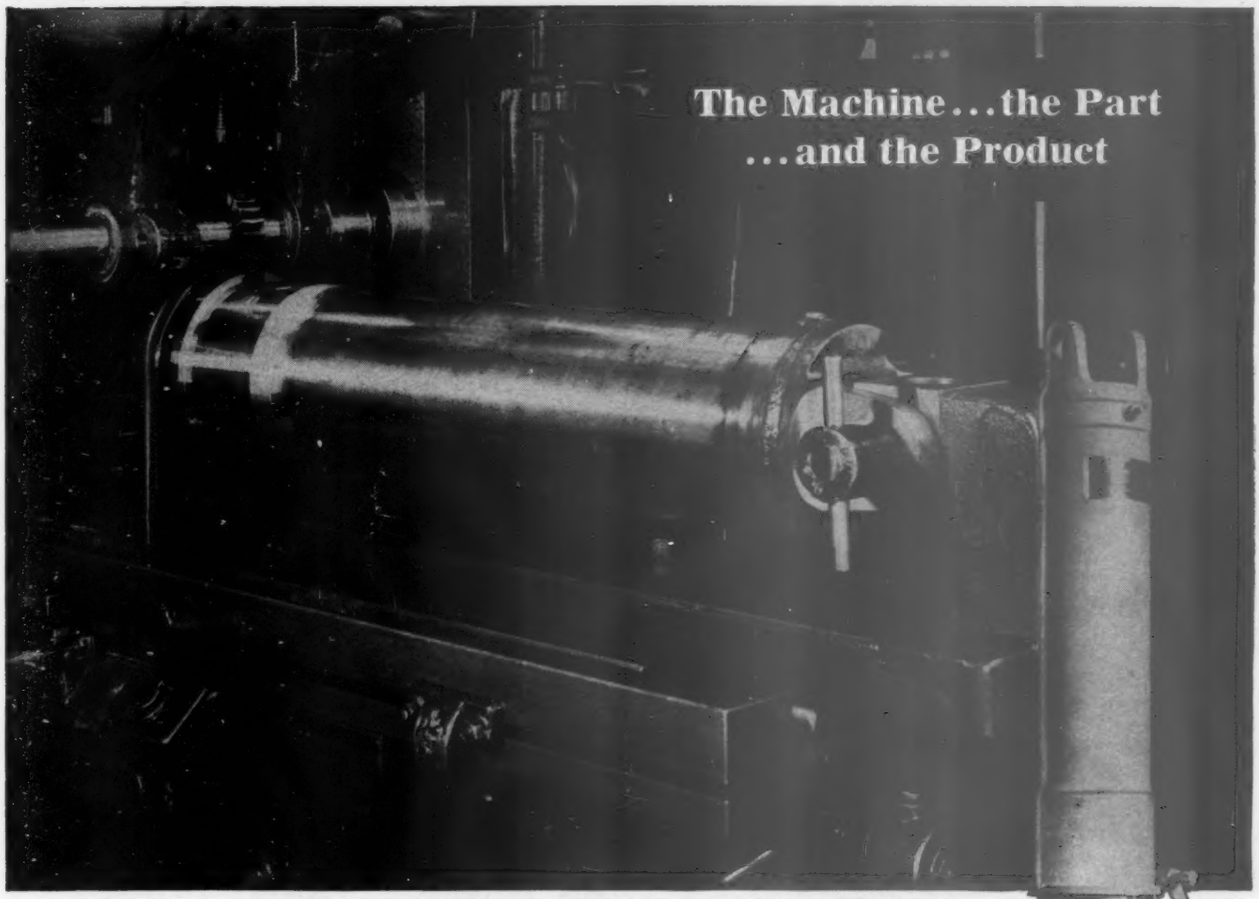
On assembly jigs and fixtures and *wherever* a portable drill is used or a plus .0005 to a plus .0015 hole tolerance meets specifications, Aero Tool *Semi*-precision Drill Bushings save money and time without sacrifice of accuracy or efficiency.

Send *today* for 28-page catalog on production tools by Aero Tool.

**AERO TOOL CO.**

**CUPFORGED AVIATION TOOLS**

AERO TOOL COMPANY, 233 WEST OLIVE AVENUE, BURBANK, CALIF.




*Even small operations in the production of a Pneudraulic Shock Strut require large fixtures and massive, extra-rigid equipment. Above is pictured a keyway being milled in an outer cylinder.*

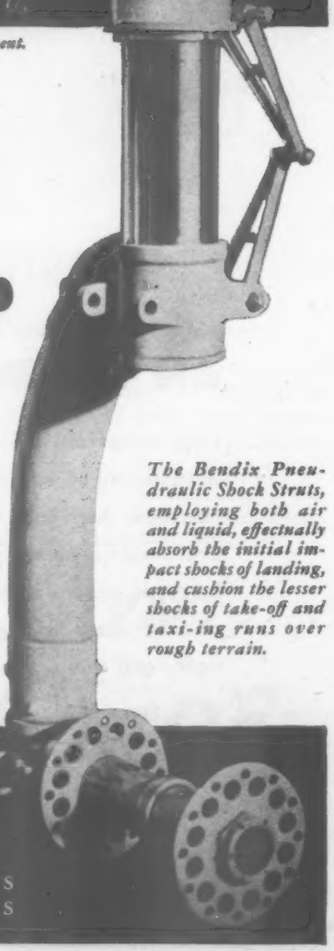
# America's most important *"Military Secret"* is simply good American workmanship

We sincerely believe the precision workmanship which we have endeavored to illustrate as characteristic of Bendix Pneudraulic Shock Struts, Airplane Brakes and Wheels, is typical of every part of an American-built airplane.

We sincerely believe it is appreciably finer than America's foes are able to maintain.

We sincerely believe this fact will prove to be a major deciding factor in our nation's battle for Victory.

BENDIX PRODUCTS DIVISION
OF BENDIX AVIATION CORPORATION



*The Bendix Pneudraulic Shock Struts, employing both air and liquid, effectually absorb the initial impact shocks of landing, and cushion the lesser shocks of take-off and taxi-ing runs over rough terrain.*

*Bendix* LANDING-GEAR EQUIPMENT

AIRPLANE WHEELS AND BRAKES · PNEUDRAULIC SHOCK STRUTS
SWIVELABLE AND STEERABLE TAIL-KNUCKLES · PILOT SEATS

# A Tale of Two Factories

ONCE UPON A TIME there were two aviation manufacturers who lived and labored not far away from each other in factories that had grown up to huge proportions almost over night. Each of these men worked furiously by day and night, casting aside many worldly pleasures in their sincere efforts to help beat Hirohito and Hitler. That is about as far as their similarity goes.

The first of these men considered it part of his job to walk out in the plant and pat a worker on the back once in a while. Even when his payroll expanded many times he tried to remember as many of his workers as he could by their first names. When that became difficult, he instructed his executive assistants to do their share of back patting and name calling. When labor agitators arose among his workers he found out who they were and tried sincerely to discover the reason for their discontent. His personality made him successful in disarming his potential enemies before they became real ones.

When illness plagued the family of the foreman of the fuselage department, he knew that he could find a friend in the head office. It didn't take long for all the men in the fuselage department to know that they were looked upon as human beings by the fellows at the top. When Christmas Eve came, each man received a turkey in the old American tradition. But with it he received a handshake and a smile from the boss, even though the boss suffered such manual paralysis that he couldn't carve his own turkey the next day. Nor did he soon recover from the healthy grasps of many thousands of workers. But the production index went up and that is all that mattered.

When springtime came, the workers flocked to the annual company outing and there they found the bosses frolicking with all the rest. Several days passed before the chief felt well again after the strenuous exercise of the picnic. But again production indexes went up.

This manufacturer did these things sincerely. His paternalism was not synthetic. It was his firm belief that management and labor should work as a team for best results and his personality permitted him to impart that feeling to his workers. His human touch reached them subconsciously as well as consciously.

The second of our manufacturers retired to his fur-lined office and elected to remain a man of mystery as far as his employees were concerned. His workers heard of him, but never saw him. When they were in trouble they knew they were not welcome in his holy-of-holies. He assumed that his employees had no interest in anything in the world excepting the size of their pay checks and he treated them as such. They sensed his attitude and played along with the idea. Agitators thrived unchecked and discontent spread all about the factory.

When Christmas Eve came, each worker was presented with a five dollar bill—by a member of the paymaster's department. The big shots had neither time nor inclination to make personal appearances. Nor did they turn up for the annual outing in the spring. And the boss sat in his plush-lined sanctum and wondered why production lagged and why he should have an unfair share of labor trouble.

Experiences of this kind are not confined to the aviation business. They crop up in all of the chapters of industrial history. But when you look back over the records of industrial organizations, one basic truth stands out among all others. The only lasting solution for the labor-management relationship problem is education of the worker. The most successful managements are those which have taken workers into their confidence and have foreseen and answered their employees' questions before they developed into mass resentment. Public relations executives must work very closely with those responsible for personnel in a broad gage program of education, based on frankness and confidence. And with education will come a new appreciation on the part of the worker of both his privileges and responsibilities.

Never before has an industry become so great so fast as aviation. It behooves all concerned with its management to study the methods of other great industries and thus to reach and exceed them in stature. A satisfactory solution of the problem of human relations will do much toward the attainment of this stature.

Leslie E. Neville

AIR WAR around the world is tightening slowly to advantage of the United Nations. Britain's command of the Islands' air seems secure, though England still will take some hard poundings.

As near as one could add the score from here, German and Russian air power was in a deadlock, stiffened by cold. What will happen as the sun warms up these two hornets nests cannot be guessed. Germany will have to fight on both the British and Russian fronts, and therefore cannot hit in full force on either.

In the East, American heavy bombers and fighters are increasing in number, and the Allies are taking over in the Australian sky. But the drive northward may be slow, because the bulk of munitions and planes are still going to Russia to fight Germany, which is still the giant among our enemies.

It is unfortunate that the whys and wheres and hows of the air battle cannot be told. AVIATION'S editors have learned more than can be printed—enough, at least to keep them from going far wrong in presenting the news. And along with this limited information, the editors have learned the reasons why the people cannot be informed of their own battle. If you could sit in with Air Force officers, and hear these reasons, you would be satisfied with the meager information you are getting.

Here is an example. A news dispatch from the Eastern stage made known what naval units were used in a recent operation. The Japanese knew that those units must necessarily return to a certain place. During the next few days you read in the papers that they were bombing certain military objectives. Actually, they were hitting at those naval units, which had been located for them by the news.

Army and Navy apparently do not intend to ask that clamps be put on our free speech and our press. But they do plead that everybody be careful.

Air Force officers are crying for airplanes. Though we are short of ships and guns, the general staff joins in the plea for planes, seeming to consider them the main weapon.

No doubt you have read in the papers that neither merchant nor combat ships can operate within range of land-

# AMERICA AT WAR

*North American B-25 bombers carrying varied insignias of United Nations' air forces. These high performance medium bombers are going to every fighting front on the globe.*

*These Lockheed reconnaissance bombers and personnel transports pour in a steady stream to all the far-flung fighting outposts of the British Empire. The weapons of Democracy's arsenal are distributed far and wide.*

*Boeing trainers for five air forces in formation.*

based planes. The editors are able to confirm this point, definitely. A country that does not have enough air power to control the air over its ships, simply has to stay out of range of land planes. That is a mighty important fact. It is one of the main reasons why England is still fighting, and it is one of the main reasons why the United Nations are at a disadvantage in the East.

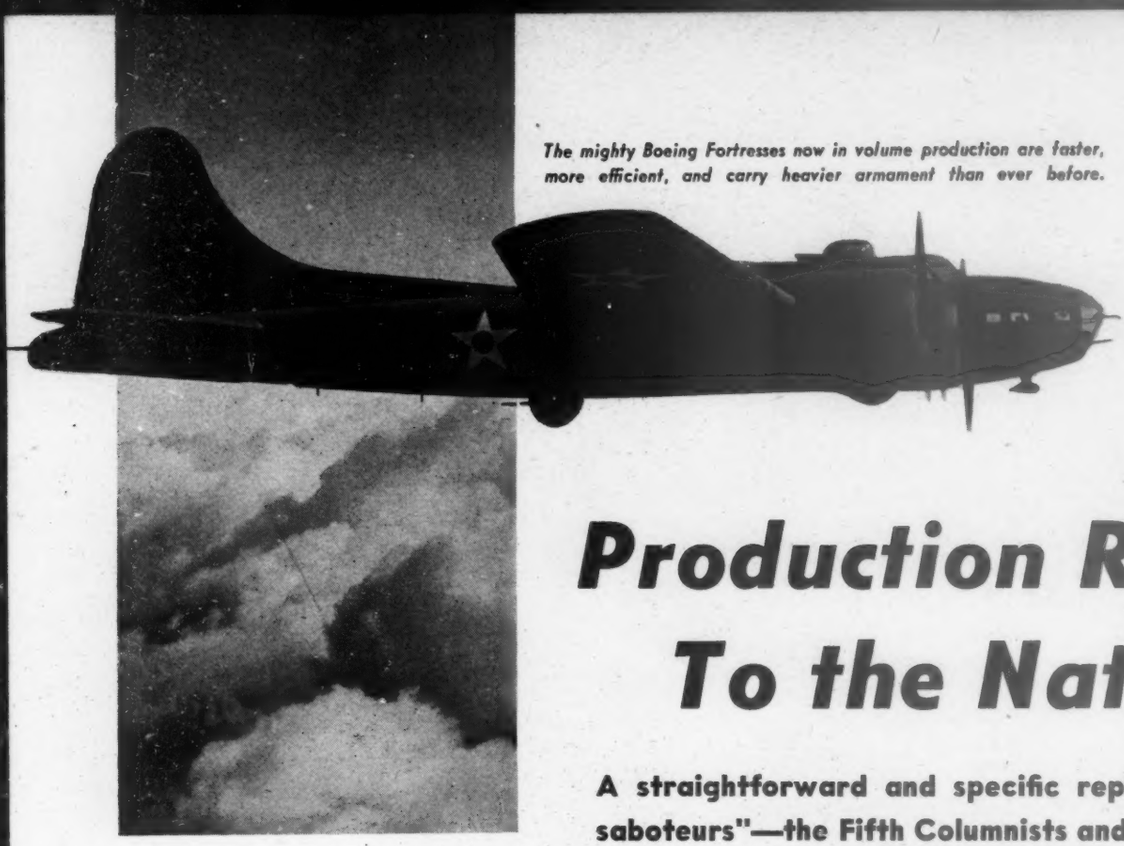
As this Communique has said before, the Japanese control the air over their theater of war largely because they are unopposed in force. In this connection, the writers have another confirmation. They have said, in this space, that Japanese airplane production is not more than 500 units per month. The statement was made, not long ago, by a member of the high command, that Japan's over-all production of war equipment is about one tenth that of the United States. This included airplanes, and you can figure for yourself that Japan is building less than 500 planes a month.

Why don't we go over there and beat their pants down? Because nearly every one of a baker's dozen of Allied fronts is crying for American warplanes. Trying to fill up those places with aircraft is a heartbreaking task, like pouring water in a gopher hole. But even the longest and deepest gopher hole can be filled up. And the vast present and potential production of British and American planes will, in good time, turn all those empty spots into stingers pointed at the Axis.

Meanwhile, we have to wait. If it were not for Russia and Britain and the Caribbean and Alaska and Panama and both our coasts swallowing airplanes and occupying our ships, Japan would be a pushover.

We have to wait because we never had enough bases in the first place, and the Japanese now have all we had. We will get bases by using Australia as a springboard and retaking captured territory in the Indies, in the Philippines, in Malay,

(*Turn to page* 239)



*The mighty Boeing Fortresses now in volume production are faster, more efficient, and carry heavier armament than ever before.*

# Production Report To the Nation

**A straightforward and specific reply to the "oral saboteurs"—the Fifth Columnists and their unwitting dupes—who would attempt to discredit America's warplane production achievement through false report, rumor and innuendo.**

**By COL. JOHN H. JOUETT**
*President, Aeronautical Chamber of Commerce of America, Inc.*

IN THE YEAR which has elapsed since I last reported to readers of AVIATION on the production achievements of the aircraft manufacturing industry, the plane builders have performed continuing miracles of production which throw into the shade their attainments of 1940, impressive as was the job done during that critical year.

Events which have rocked our civilization to its foundations have occurred since my last report. Russia and Germany have locked in a titanic struggle; many old war fronts have changed, and most important to all Americans, the United States has been savagely attacked without warning and is now devoting every energy to full-out war production in order to equip armies and navies—ours and our allies'—to smash the Axis Powers.

One of the increments of U. S. involvement in the war has been establishment of a necessary, rigorous censorship to keep information of value from reaching the enemy. Therefore, my report on production cannot be written in cold figures, as was my report last June. But I can report that, as of today, production of military airplanes in the United States has almost doubled in number since Pearl Harbor. In poundage, an even more important index, the increase is *substantially higher*.

The magnitude of the job which has been done becomes even more apparent with realization that it has been done, to date, almost entirely by an industry that as recently as September 1939—the date on which world hostilities opened—employed only about 85,000 workmen. I am not permitted to describe in figures the spectacular increases we have made in floor space, in employees since that time. However, the fact that the already-impressive production at the time of Pearl Harbor has been nearly doubled in the five months which have followed should furnish an intelligible yardstick with which to measure the task of expansion which has been accomplished. When the auto-

*Master and apprentice. A familiar sight in aviation plants are these "soldiers of production", learning by doing. These workers check a machined crankcase for a Lycoming aircraft engine.*

Press Association Photo

*Row upon row of torpedo-like B-26 medium bombers flow down the multiple assembly lines at the Glenn L. Martin plant in Baltimore.*

*Soon the vast resources of America's automotive industry will begin to make its productive capacity felt in America's mounting output of aircraft. Here Wright Aircraft engine pistons flow from production lines of Hudson Motor Car's aircraft division.*

mobile industry, even now getting into plane production, really gets rolling, a wave of warplanes that the Axis cannot possibly breast will be taking to the skies.

What aircraft production might have been today, had it not been for shortage of materials, is almost breathtaking. Almost every plane plant in the country could increase its production from 25 to 50 percent—*today*, the first of May—were the materials available. By materials I refer not only to raw materials, such as aluminum or nickel, but also to such fabricated items as forgings, extrusions and the hundreds of highly machined parts. These materials and parts, turned out by foundries and mills and hundreds of machine shops and plants, are vital to us in our efforts to keep our assembly lines moving at capacity.

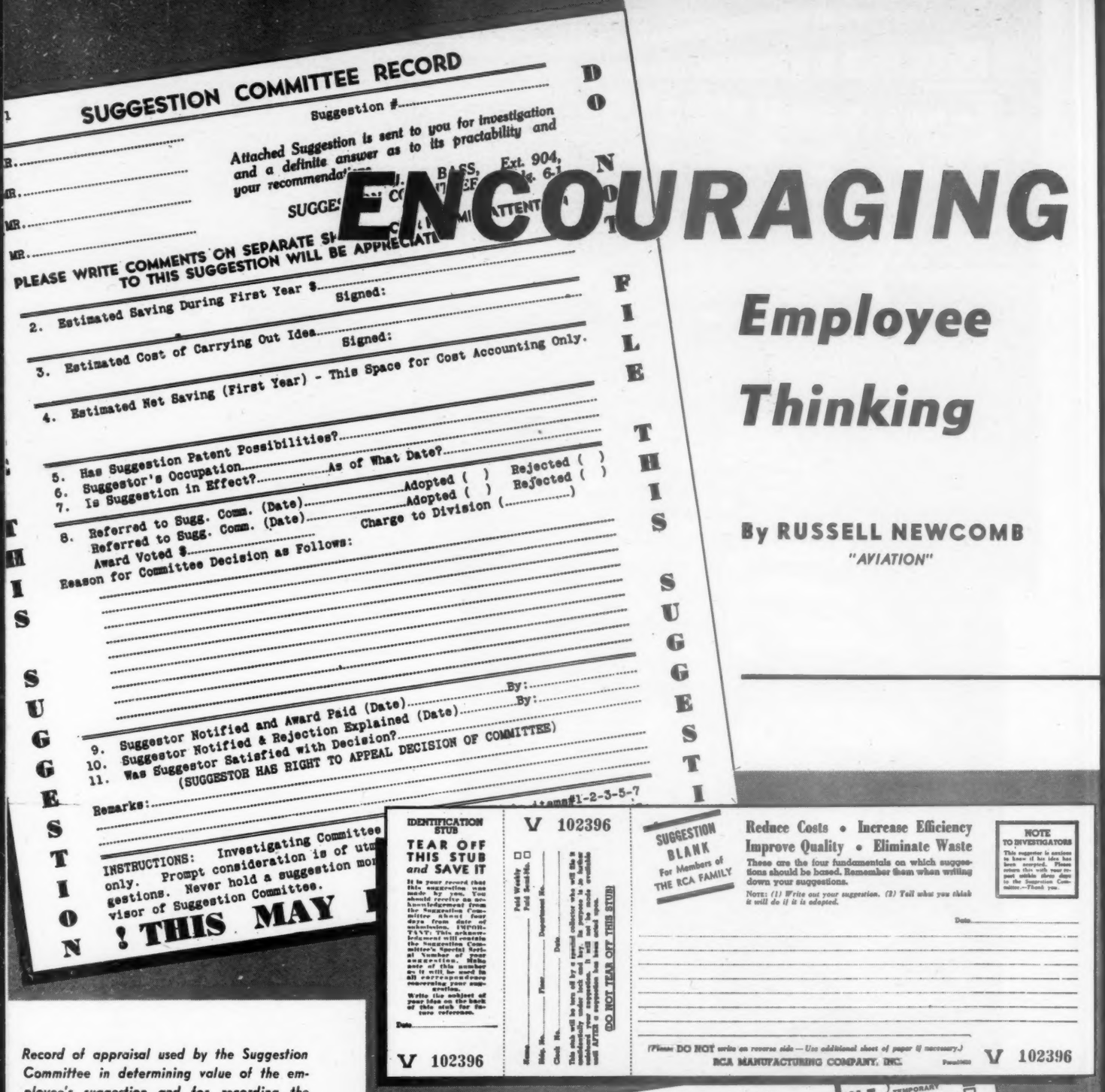
I have no criticism to offer; but you recently have heard about the War Production Board's campaign to stimulate production by inspiring management and labor to greater effort. In our case it was unnecessary. Our plants from the first have been using the materials as rapidly as they could be received under government allocations. We are only one of the industries in the war effort. It isn't for us to tell the government that we should be allocated all the available supply of certain critical materials at the expense of those plants making ships, tanks, guns and hundreds of other items of needed equipment. The government is faced with the tremendous task of deciding how the materials should be allocated. This materials bottleneck will be broken in time, and ours and other industries will write new and inspiring chapters in American industrial history.

The aircraft industry, and the air forces, of which the aircraft industry considers itself a vital part, are not resting on any production laurels they have gained to date. Both realize that the outcome of the war, and the future destiny of America and the world, depend upon us getting to the fine pilots of the United Nations—*planes a' plenty in plenty of time.* To that end we are working day and night, and to that end are working with us the countless thousands of aircraft workmen, "the

(*Turn to page* 239)

# ENCOURAGING Employee Thinking

By RUSSELL NEWCOMB
*"AVIATION"*



SUGGESTION COMMITTEE RECORD

Suggestion #.....

Attached Suggestion is sent to you for investigation and a definite answer as to its practability and your recommendat... J. BASS, Ext. 904, ...g. 6-1

SUGGE... C... ATTENT... O...

MR.....
MR.....
MR.....

PLEASE WRITE COMMENTS ON SEPARATE SH... TO THIS SUGGESTION WILL BE APPRECIATE...

2. Estimated Saving During First Year $..... Signed:.....
3. Estimated Cost of Carrying Out Idea..... Signed:.....
4. Estimated Net Saving (First Year) - This Space for Cost Accounting Only.
5. Has Suggestion Patent Possibilities?.....
6. Suggestor's Occupation.....
7. Is Suggestion in Effect?.....As of What Date?.....
8. Referred to Sugg. Comm. (Date).....Adopted ( ) Rejected ( )
   Referred to Sugg. Comm. (Date).....Adopted ( ) Rejected ( )
   Award Voted $..... Charge to Division (.....)
   Reason for Committee Decision as Follows:
9. Suggestor Notified and Award Paid (Date).....By:.....
10. Suggestor Notified & Rejection Explained (Date).....By:.....
11. Was Suggestor Satisfied with Decision?
    (SUGGESTOR HAS RIGHT TO APPEAL DECISION OF COMMITTEE)

Remarks:.....

items#1-2-3-5-7

INSTRUCTIONS: Investigating Committee ... only. Prompt consideration is of utm... gestions. Never hold a suggestion mor... visor of Suggestion Committee.

! THIS MAY ...

THIS SUGGESTION ... DO NOT FILE THIS SUGGESTI...

IDENTIFICATION STUB

TEAR OFF THIS STUB and SAVE IT

It is your record that this suggestion was made by you. You should receive an acknowledgement from the Suggestion Committee about four days from date of submission. IMPORTANT: This acknowledgment will contain the Suggestion Committee's Special Symbol Number of your suggestions. Make note of this number as it will be used in all correspondence concerning your suggestion.

Write the subject of your idea on the back of this stub for future reference.

Date.....

V 102396

Paid Weekly
Paid Semi-Mo.

Name..... Dept. No.....
Bldg. No..... Floor..... Department No.....
Clock No..... Date.....

This stub will be torn off by a special collector who will file it confidentially under lock and key, the purpose is to make sure that AFTER a suggestion has been acted upon.

DO NOT TEAR OFF THIS STUB

V 102396

SUGGESTION BLANK
For Members of THE RCA FAMILY

Reduce Costs • Increase Efficiency
Improve Quality • Eliminate Waste

These are the four fundamentals on which suggestions should be based. Remember them when writing down your suggestions.

NOTE: (1) Write out your suggestion. (2) Tell what you think it will do if it is adopted.

NOTE TO INVESTIGATORS

This suggestor is anxious to know if his idea has been accepted. Please return this with your report within three days to the Suggestion Committee.—Thank you.

Date.....

(Please DO NOT write on reverse side — Use additional sheet of paper if necessary.)

RCA MANUFACTURING COMPANY, INC. Form 0503

V 102396

Company Correspondence
Camden, New Jersey

FILE { TEMPORARY / PERMANENT

Approved by or Answered.....

Date.....

16303

Div.

To

Subject:—

Your suggestion, Serial No.....has been received. There are many suggestions coming through daily, and it requires considerable time to investigate every angle thoroughly.

However you should hear further about your suggestion within three or four weeks. If no information is received within this period, PLEASE feel free to call me on extension 904 or see me personally Bldg. 6-1.

Please retain this acknowledgment for future reference to your suggestion. The serial number is your record that this suggestion was made by you.

Your interest as evidenced by your suggestion is sincerely appreciated.

J. W. Bass
SUGGESTION COMMITTEE

*Record of appraisal used by the Suggestion Committee in determining value of the employee's suggestion and for recording the complete case history.*

*Suggestion form used by the employee in transmitting his idea to the Suggestion Committee for consideration*

*Form letter sent to the contributing employee upon receipt of his suggestion by the committee*

## *RCA "Beat the Promise" plan sets a model for the production drive*

**SEVERAL MONTHS before Donald Nelson and the WPB outlined plans for a nation wide war production drive, the management and employees of the RCA Manufacturing Company took the lead in joining in a cooperative effort to speed the flow of essential defense materials. Called "Beat the Promise" the RCA program was outstandingly successful, attracting nation wide attention, and serving as a model for many similar plans.**

**Under the energetic supervision of Thomas F. Joyce, RCA vice-president in charge of public relations and internal education, posters, rallies, department competitions, factory visits from men in uniform, and other forms of dramatization, were used to enlist and sustain the interest of both workers and executives. A detailed story of the methods used in the "Beat the Promise" plan was told in a special supplement of the March, 1942, issue of *Factory Management and Maintenance*. AVIATION has arranged to secure a limited supply of these supplements which will be made available to its readers, upon request, as long as the supply lasts.**

**One of the immediate results of the program was an impressive jump in the number and value of the production ideas received via the RCA employee suggestion system, which had been functioning in a highly satisfactory manner for a number of years.**

**Because today an increasing number of aviation companies are extending their use of an employee suggestion system to help speed up production methods, the accompanying article presents an account of the factors that have made the RCA suggestion system a steady source of time and money saving production ideas, and an essential part of this company's war effort.**

ESSENTIAL to the war production effort, said Donald Nelson in his first radio broadcast to the nation, will be a constant exchange of ideas and thinking between management and labor. The tremendous problems involved in gearing the nation's production to the unparalleled requirements of a war in two hemispheres can be successfully solved only if the ideas and suggestions of the rank and file workers are encouraged and, when they contribute to the efficiency and speed up of the production effort, put to immediate practical use.

Employee sugestion systems, by which a regular procedure is established by management for the rewarding of employees for practical production ideas, have long been in use by many progressive firms. Under the spur of the war production effort and Mr. Nelson's urging, these systems are bound to assume a new importance and to be adopted by many plants which previously had ignored their possibilities.

In the aviation industry, a number of companies have had outstanding employee suggestion systems. Within a two year period, one of the more progressive aircraft manufacturers unearthed more than 50 patentable ideas and a much larger number of useful ones that were not patentable from its employees of the rank below foremen.

Among the larger companies supplying aircraft accessories and fittings, the RCA Manufacturing Company has, over a period of years, maintained an employee suggestion system which has been extraordinarily successful, and winning national attention.

Already through the RCA suggestion system have come ideas which have broken serious bottlenecks in turning out vital war equipment. In one instance, the material needed for a certain element in the radio equipment of America's military plane disappeared as a result of a war shortage, thus threatening a serious bottleneck. Through an idea received via the employee suggestion system, it was possible to work out a method for turning out these parts from new and different material. As a result, this particular bottleneck was broken, and the radio equipment was ready on time for the fighting planes.

Other RCA employee suggestions that have helped to speed up the production of essential war equipment have included an idea that has materially reduced the number of rejections of finished radio receivers, and another which has eliminated entirely a time consuming sand-blasting process for an interior unit of a radio receiver. Other ideas, equally useful and valuable are constantly being put into practical operation.

A quick survey of the factors that have made the RCA employee suggestion system productive of results, reveal that careful planning, an assignment of a staff adequate to keep all the details of the system flowing smoothly, plus a continuously encouraging attitude on the part of management are the "secret" of the success of the RCA system.

More than 30 thousand suggestions a year are received through the RCA system, a surprisingly high percentage of which are found to have practical value and are ultimately put into actual use. The ideas received result in waste elimination, increased efficiency, better quality, and simplification of process operations. All types of suggestions are encouraged, and every employee in the company is eligible to submit them, with the exception of executives, superintendents, department heads, members of the engineering planning department and those administering the suggestion system.

The fact that every suggestion made is acknowledged within a few days after it is placed in the suggestion box, and that the awards are paid in cash, are important factors in maintaining a constant flow of suggestions, J. W. Bass, the supervisor in charge of the RCA suggestion system, believes. The mechanics of the system are simple, yet constant attention to detail is needed to keep it working smoothly, as Mr. Bass explains it. The full time of Bass and four secretaries is devoted to the job of acknowledging and keeping track of the suggestions submitted.

Suggestion boxes are placed conspicuously in each department for the receipt of suggestions. Attention is focused on the boxes by means of spotlights, posters that are frequently changed, and constant publicity on bulletin boards and in the company house organ. Collections are made from the boxes at least twice a week. A pleasantly worded form acknowledging receipt of the suggestion, and explaining that it may take several weeks to reach a final decision concerning its acceptability, is sent to the employee within a few days after it is received. At the same time the suggestion is given a code number, which is used in all subsequent references to that suggestion. The employee is given this code number when the suggestion is first acknowledged, but those who decide on its final adoption know it only by the code, and have no information concerning its source, so that any possible personal prejudices are eliminated.

Except for the small percentage that are immediately ruled out as being impractical, each suggestion is sent to the foreman of the department in which

(*Turn to page 243*)

*Here is a section of one of the drilling shops where women operators are already in production. Note air conditioning conduit on ceiling. A careful watch is kept on humidity.*

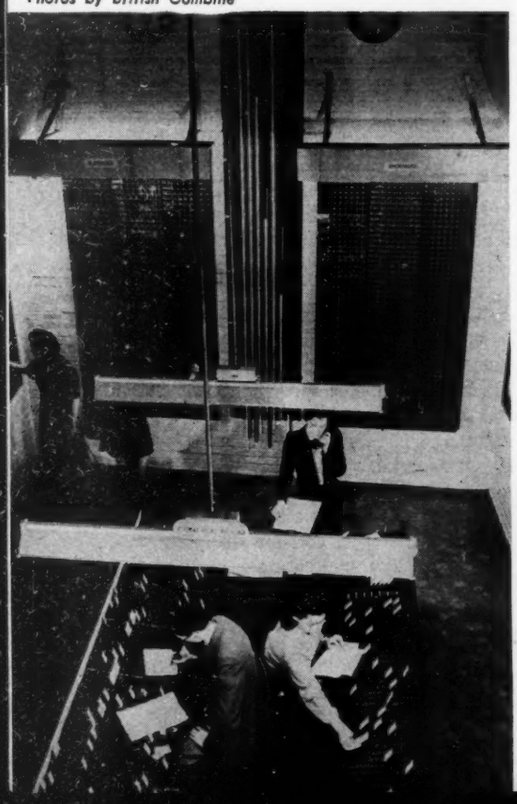
*The machine shop hewn out of oolite. Most of the supporting pillars are of natural formation. The man is testing the roof from which are suspended the fluorescent fixtures.*

*Girl store keepers check parts in and out in a store room hollowed out of solid chalk. At regular intervals, strata of flint make a natural reinforcement against bomb bursts.*

# UNDERGROUND FACTORY

**Some scenes inside a British aircraft plant located in a chalk mine beneath the ground. Here in galleries and rooms hewn out in Roman times, modern machinery and workers carry on production in safety.**

*Photos by British Combine*



WE HAVE LONG been familiar with reports of German underground airplane factories where the Nazis sought not merely concealment but safety from bombing raids, and where an uninterrupted flow of production might be maintained.

Word has now reached us concerning similar British factories which have been located in chalk mines and quarries. Full Ministry cooperation is said tc have been given to converting disused underground works into factories for aircraft production. As in our "blackout" buildings air conditioning plants are installed and fluorescent lighting used. A control room in which is kept an up-to-the-minute picture of the many thousands of parts which are being produced daily is shown in the accompanying pictures.

*A factory production control room in operation in one of the British chalk mine aircraft works, as seen from the manager's office.*

Work on the first site began, it is reported, nearly 2,000 years ago, when, from Roman times to the present, generations of quarry workers hewed out the avenues and streets now paved with cement.

Every inch of the quarry roof was tested for strength, and, where fissures indicated weaknesses, columns of brickwork were run up from floor to ceiling. But for the most part, the massive irregular buttresses left by each generation of quarrymen made such precautions unnecessary.

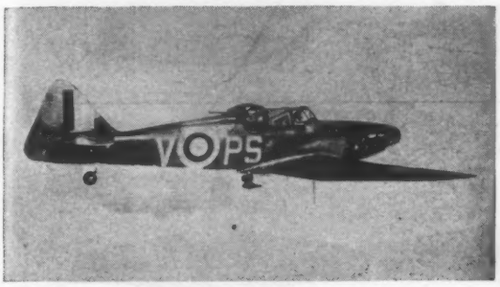
To meet the demands for still greater space, however, another million cubic yards were excavated. Three wide shafts were sunk, down which air is forced by fans. Four others take away the air no longer fit to breathe. To safeguard against bombing, one intake shaft penetrates into the mine in a sweeping curve; the others are vertical, but capped with concrete slabs several feet thick. Walls

(*Turn to page* 247)

# British Aircraft

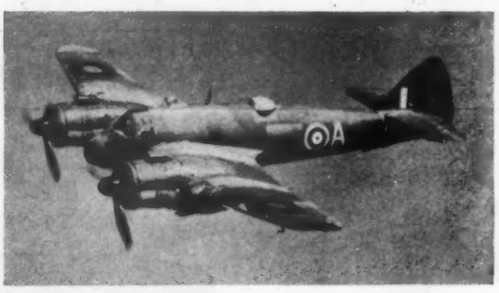
**Photos and silhouettes of military planes which have stopped the Nazis over England and are carrying the offensive to the enemy.**

BRITISH MILITARY TYPES are distinguished by the fact that while the fighter planes are streamlined and often graceful, the bombers are usually strictly utilitarian in appearance. They are designed for ease of manufacture and transport of parts to major assembly, as well as for great load-carrying ability. It is also noteworthy that Britain's best single-engine fighters have liquid-cooled in-line power plants. In our Air Forces, one of the best is the Republic Thunderbolt powered by a 2000 hp. radial. AVIATION's "spotters' series" will continue next month with Italian aircraft.



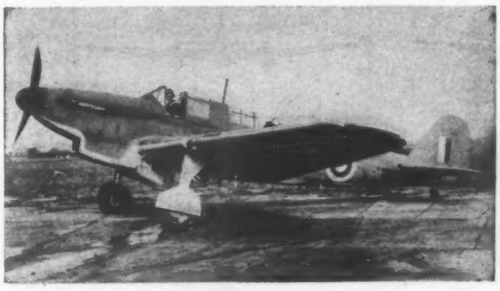
◀ Heavily armed, two-seater night fighter fitted with power operated four-gun turret over rear cockpit.

▶ Night interceptor armed with 4 cannon and 6 machine guns. Top speed is 330 m.p.h.



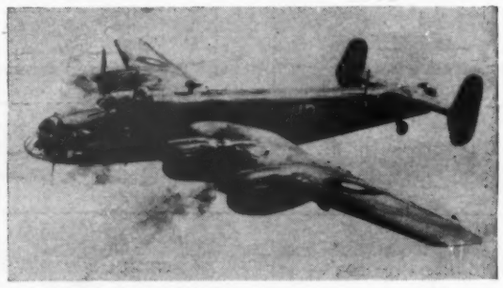
BOULTON PAUL DEFIANT

BRISTOL BEAUFIGHTER



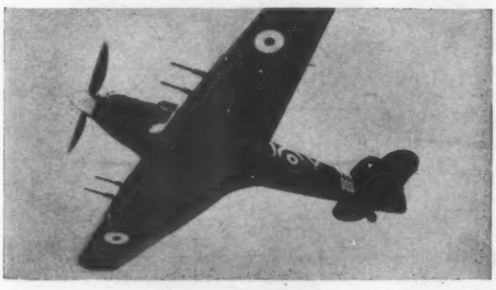
◀ Two-seater shipboard fighter armed with eight wing guns. Top speed is about 300 m.p.h.

▶ Four engine heavy bomber able to transport its bomb loading to any point in Europe.



FAIREY FULMAR

HANDLEY PAGE HALIFAX

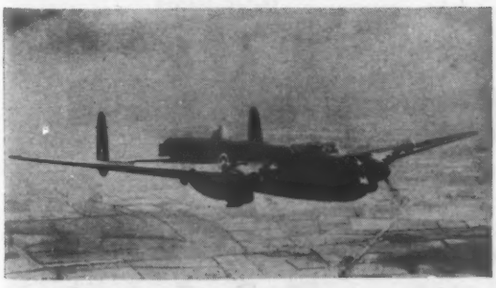


◀ A very successful single-seater fighter now armed with four cannon plus machine guns. The top speed is 335 m.p.h. at 18,500 ft.

▶ Long-range four-engine heavy bomber. It has an all-up weight of 65,000 lb. and a span of 99 feet.

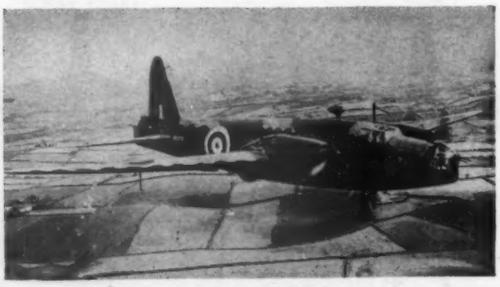
HAWKER HURRICANE

SHORT STIRLING



◀ A new heavy, twin-engine, long-range bomber. First to be fitted with new Rolls-Royce Vulture 2,000-h.p. engines.

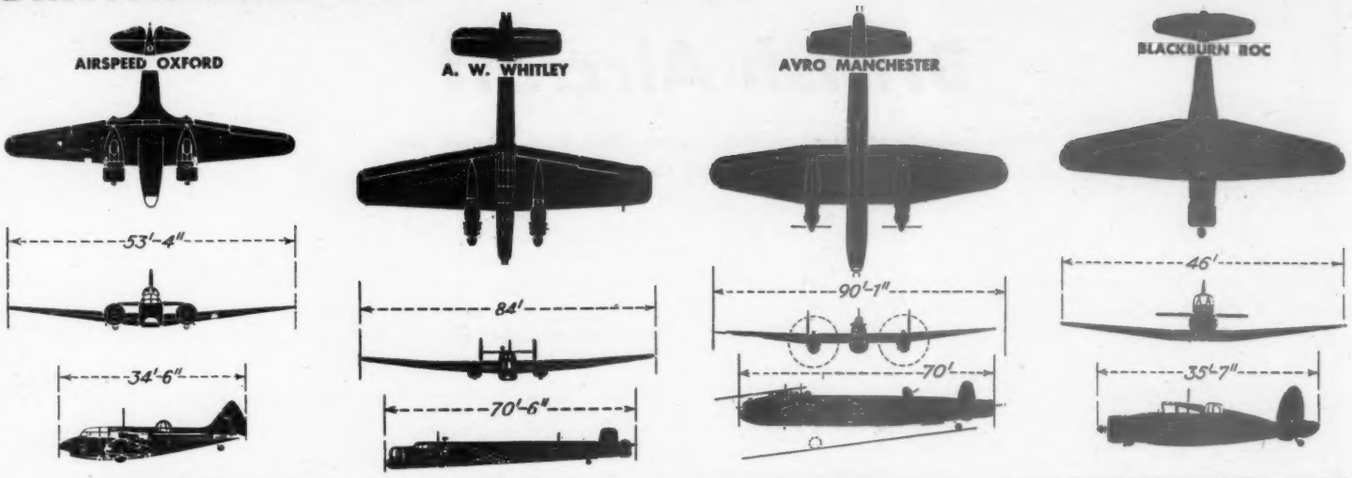
▶ A long-range medium bomber with a range of 3,200 miles at its cruising speed of 180 m.p.h.

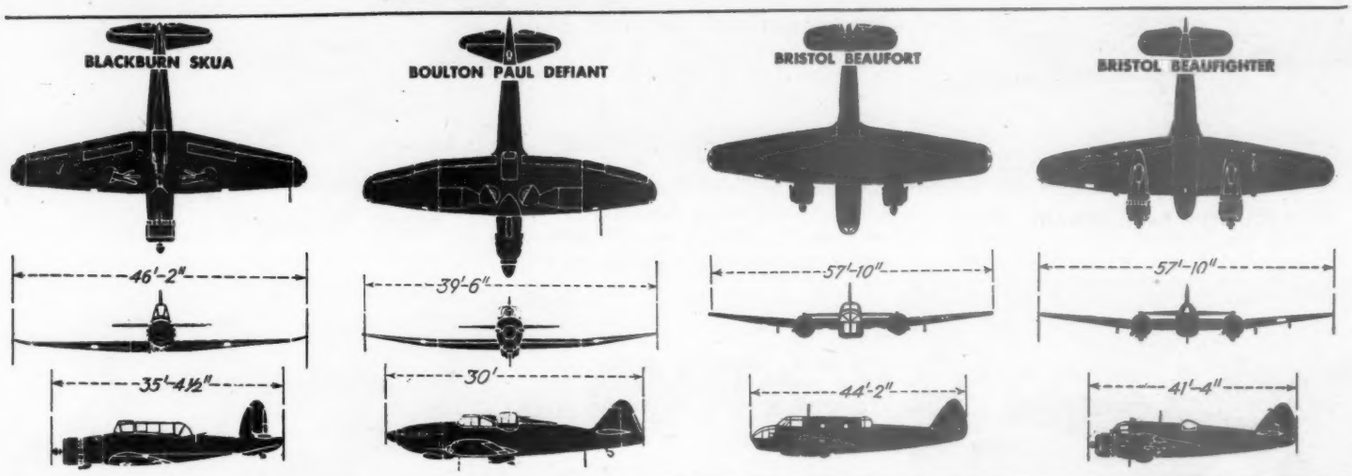


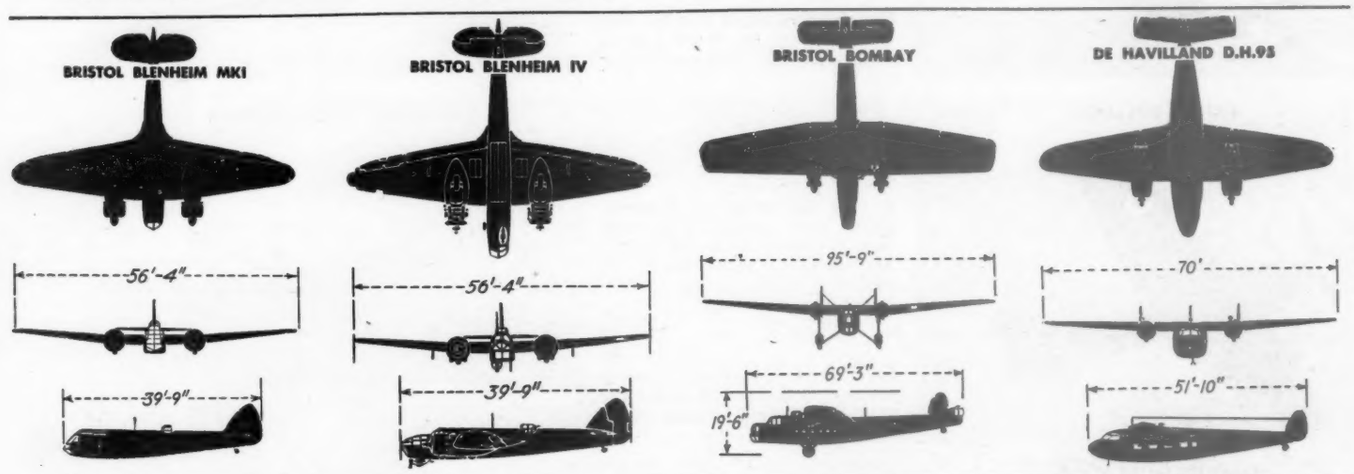
AVRO MANCHESTER

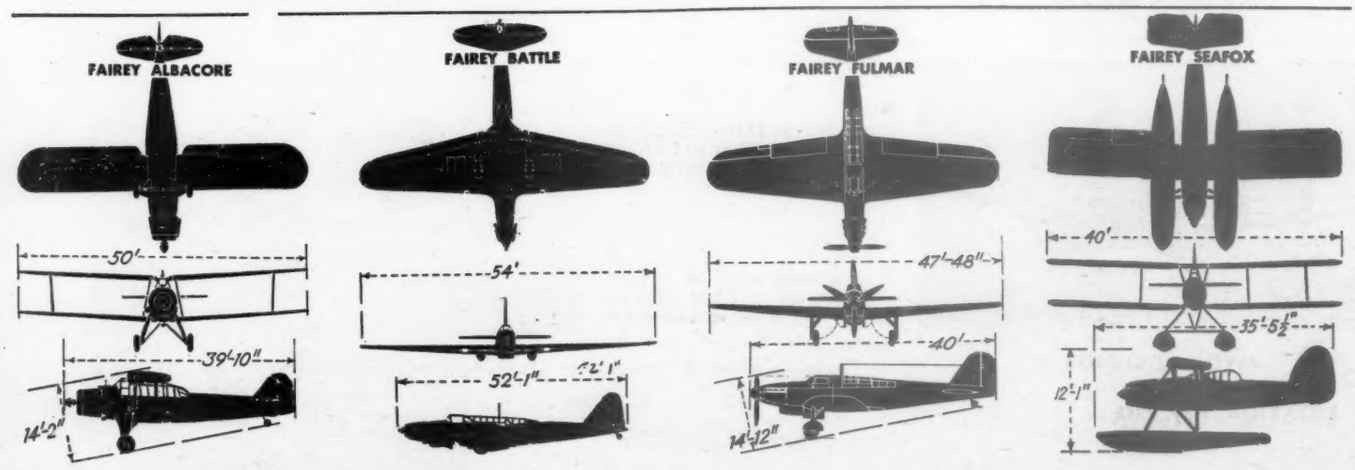
VICKERS-ARMSTRONGS WELLINGTON

# BRITISH AIRCRAFT

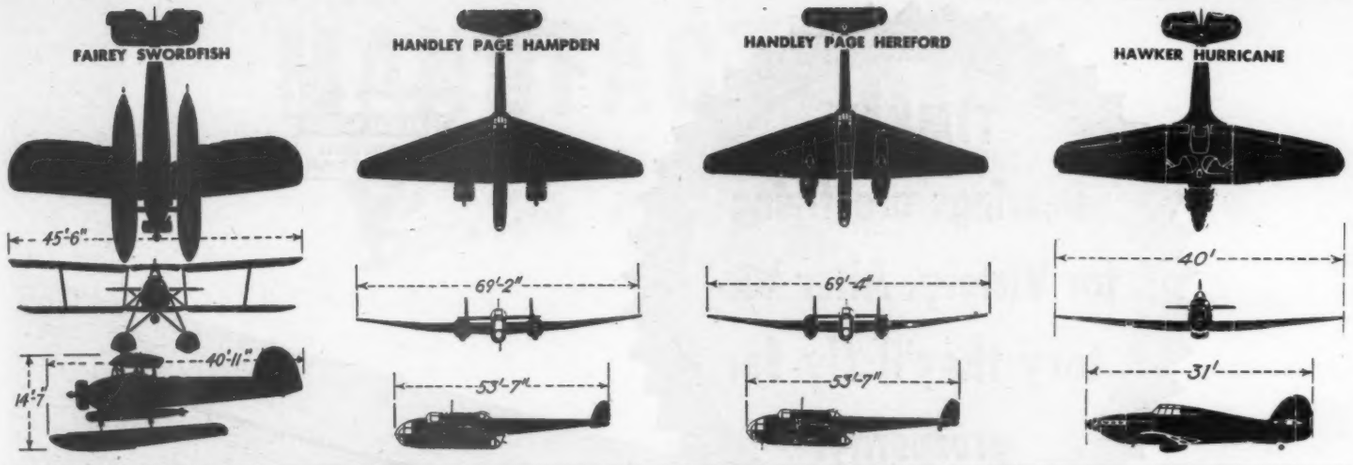


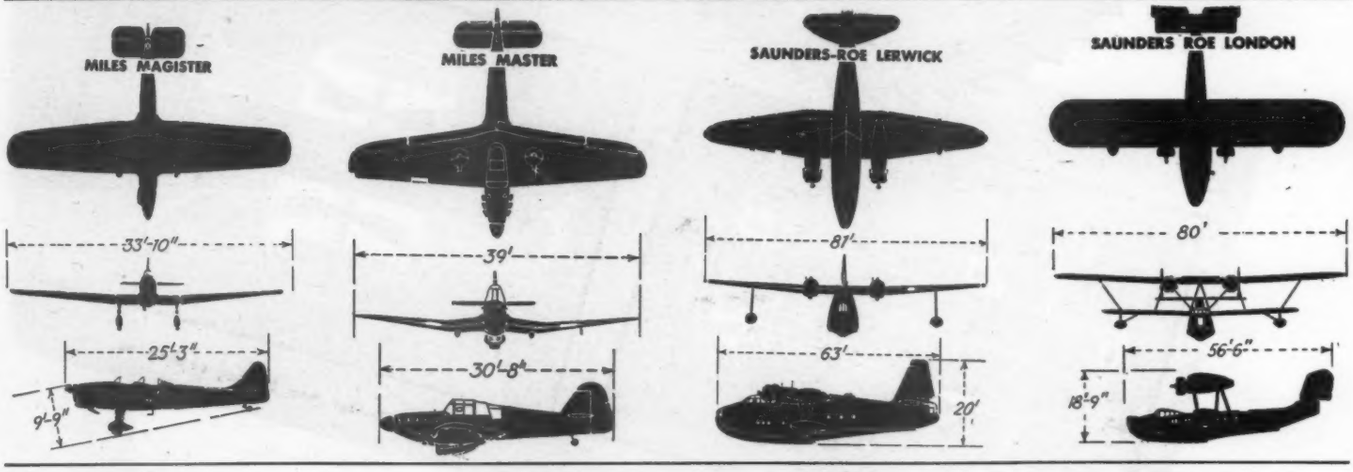



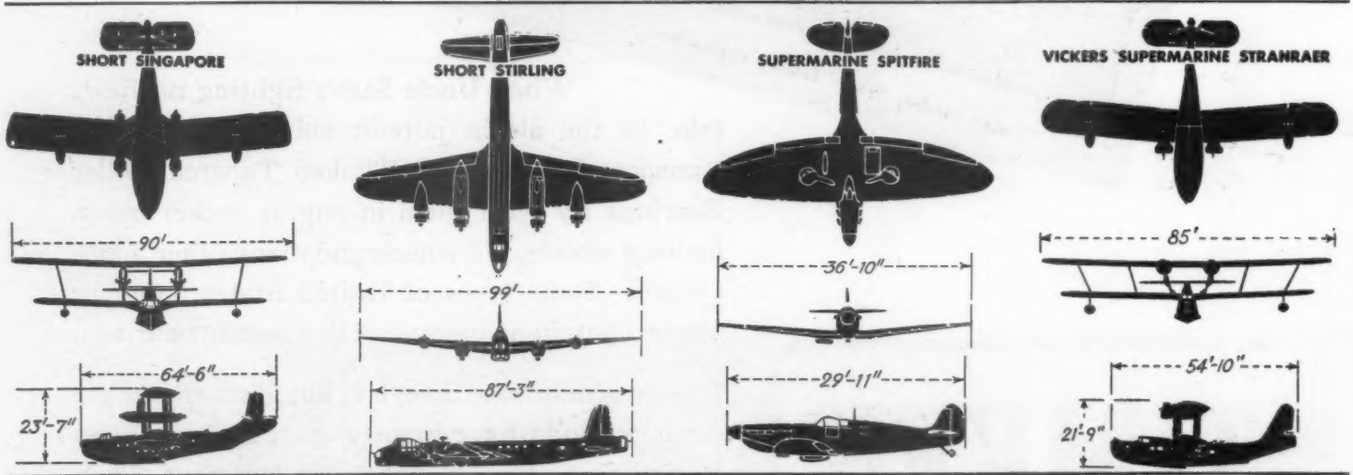



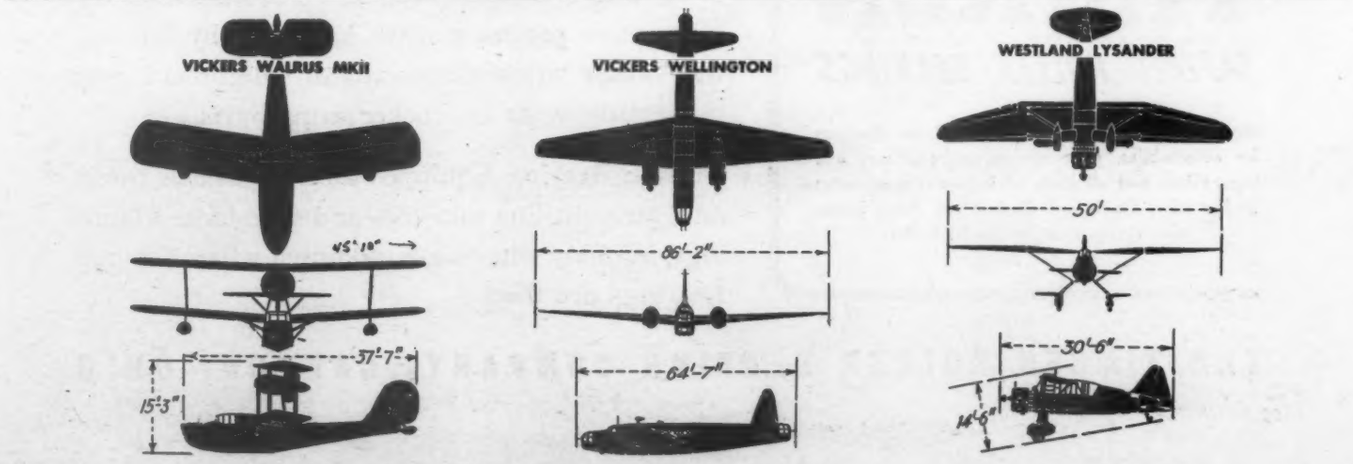



# BRITISH AIRCRAFT



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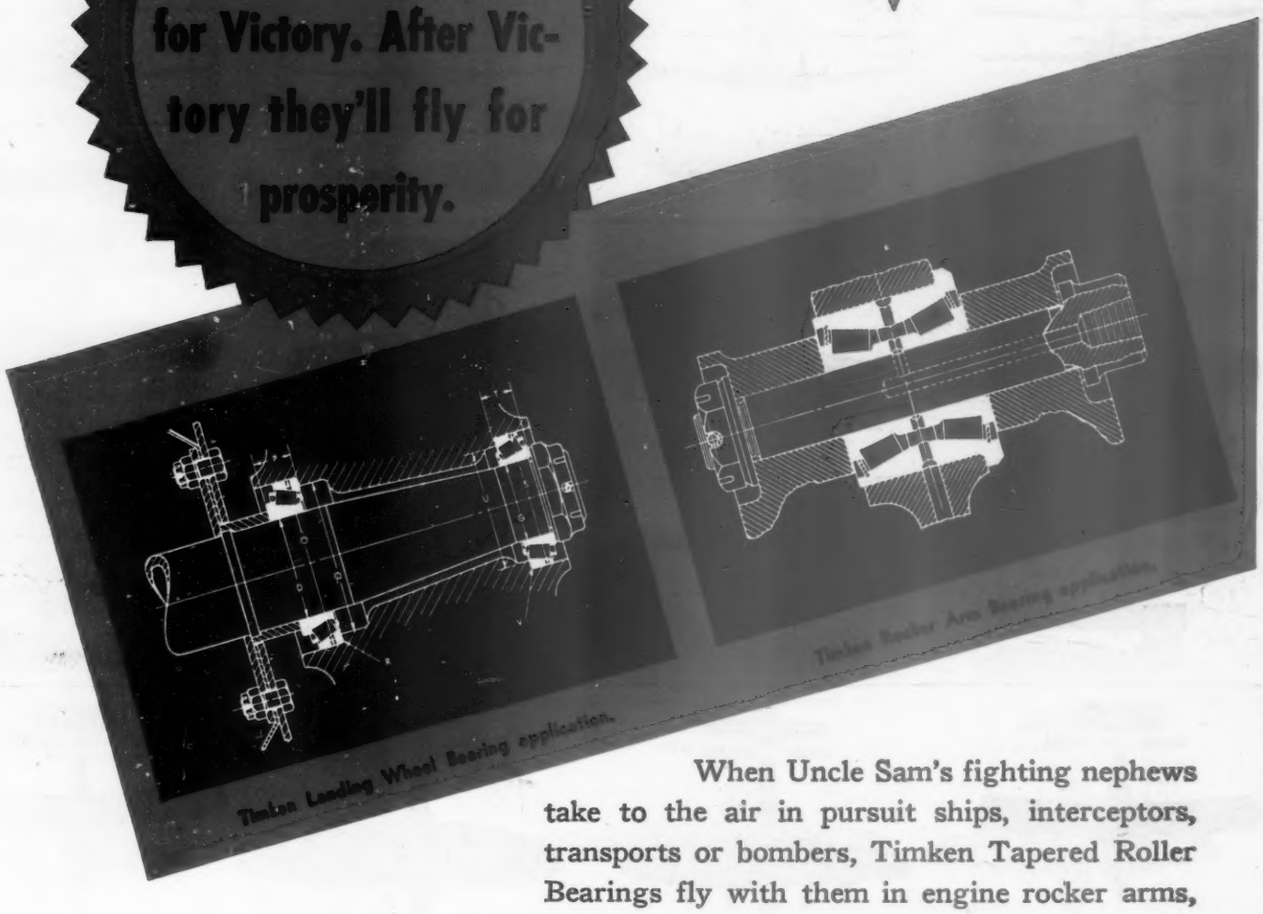


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# MANUFACTURING

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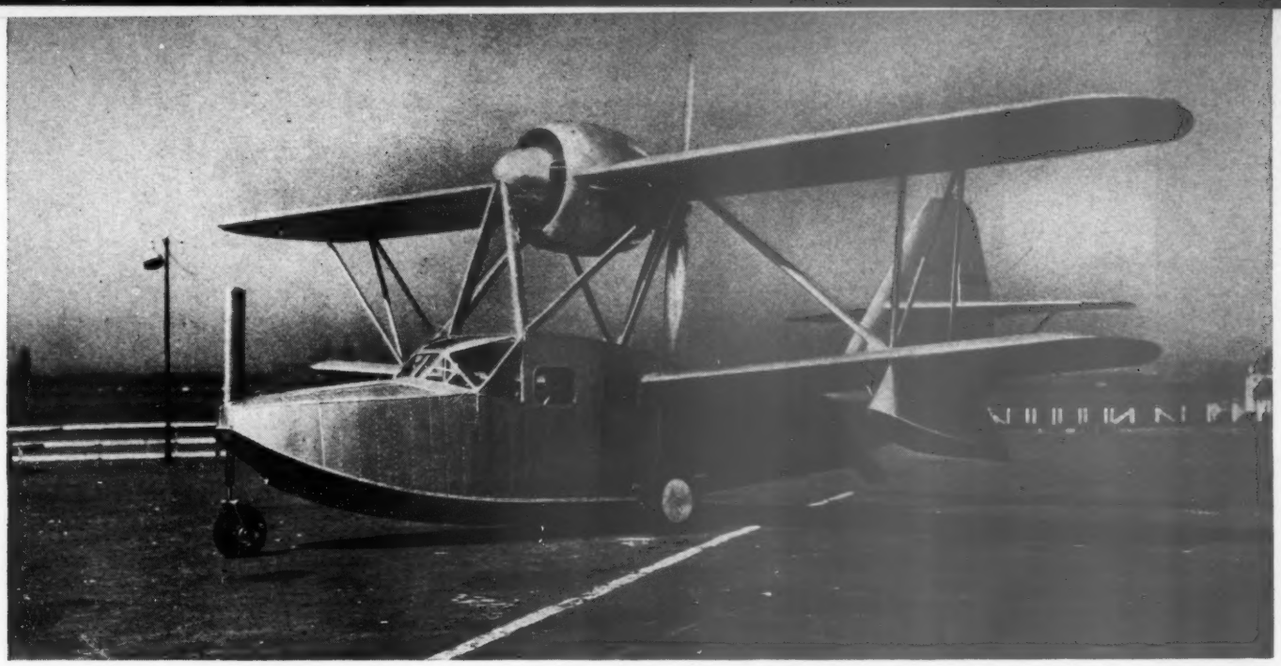


*Frank Courtney's amphibian, designed and built for Curtiss-Wright ten years ago, incorporated what were then radical features but which since have become conventional practice; namely, retractable tricycle undercarriage and extension shaft from the engine to the pusher propeller. Powered with a 330 hp. engine, it carried four passengers and baggage at a top speed of 151 mph.*

# Remote Propeller Drives

**With the impetus given aeronautical design by wartime exigencies and the consequent demand for optimum performance without regard to normal considerations of conventional practices and cost, attention of designers again is turning toward the provocative problems of "piping" propulsive power from powerplants to most efficient locations for propellers. Here is a review of progress in this field to date**

**By FRANK T. COURTNEY**

THE IDEA of putting the engine in one place and the propeller somewhere else is anything but new. The first airplane to fly had such an arrangement, and probably would not have flown if it hadn't.

The Wright brothers first placed their power unit in the most suitable place for the power unit. They then devised a propelling system and located it where it would do the most good. The power was then taken to the propellers by a transmission. The principle of that arrangement is as logical today as it was then.

And most other vehicles, both land and sea, adopt a similar disposal. Yet it has become the rule in airplanes to clamp the engine and propeller together. Like Siamese twins, where one has to go the other has to go, whatever the advantages of parting them might be. The resulting stagnating effect on general airplane design is becoming increasingly obvious.

There has, however, been plenty of reason for that state of affairs. In the last twelve years immense strides have been made in the performance of airplanes without separating engine and propeller, and these improvements have introduced, one way and another, about as many problems in aerodynamics and structures as the designers and research people could reasonably cope with.

Moreover, this is one of the rare instances where competition has *not* been good for progress; increasingly over the last few years the desirability of some other engine-propeller arrangement has been brought up, but few designers have been willing to "take a chance" on such a change. As a natural result, many designers have adopted a defensive attitude towards the old-established arrangement and have thus tended towards active opposition to the remote drive, with a consequent exaggeration of the difficulties of its problems.

So, on the score of mere desirability, the cause of the remote drive was not likely to get very far—and this despite the fact that certain classes of airplane, most notably the whole range of flying boats, cannot possibly progress without it. At present, in the flying boat, the propellers are kept clear of the water either by the sheer bulk of a lofty hull below the wing or by an air brake arrangement of the engine above the wing; which is one powerful reason why we have not got the high-performance water-based fighters and bombers which we so much need today.

Only sheer compusion, therefore, is likely to make the remote drive a commonplace of aircraft design. Since this compulsion is now well on its way, the remote drive situation *must* be taken seriously. This compulsion will come from the needs of the much higher horsepower units now impending but, since the resultant developments will be equally applicable to lower powers, the whole field of design will be affected.

## About The Author

**Captain Frank T. Courtney during World War I served in England's RAF and gave a good account of himself. Later, his ambition was to pilot a plane on a nonstop flight from England to the United States.**

**This desire was frustrated when the big Dornier-Wal flying boat in which he actually began such a flight was forced down and burned in mid-ocean. In spite of this, and a well-nigh miraculous rescue, he continued with his aviation endeavors.**

**In the early 1930's, associated with Curtiss' St. Louis Airplane Division, he designed the Courtney amphibian, a ship of unusual and advanced design. The engine nacelle was set in the upper wing and an extension shaft drove a pusher propeller behind the trailing edge. The design also incorporated a retractable tricycle landing gear.**

**Courtney conducted flight tests on the famous Boulton & Paul *Bodmin* in 1924, and around the same period was flying the Parnall *Possum*, both of which planes were notable for their remote propeller drives at that time. He has actively participated in aircraft design right up to date, particularly in the little-explored regions of this science. This article constitutes the first in a series in preparation by the author which will have as its main theme "flying boat design."**

For some ten years now general design has been completely frozen into a form in which the all-important leading edge of the wing is draped with barrels containing engines. Nobody supposes this arrangement will survice indefinitely, but it is a very simple and reasonably efficient arrangement, and the designer cannot be blamed for hanging on to it until he has strong reason for change.

Once this spell is compulsorily broken, engines and propellers will start to turn up in all sorts of locations; some of these locations will prove to be better than others, and we might as well start right now to try and find out which they are. Engines may or may not leave the wings altogether and go into the fuselage or hull; their shape will probably become less to worry about, but cooling systems will change. The tractor form of propeller may—personally I think it will—become a thing of the past. In any case, once the engine system and the propeller system come to the regarded as two separate items, such a complete change comes over the general arrangement of the airplane that the usual and normal processes of gradual and steady evolution in design are likely to be severely shaken. This is the principal reason why this should receive somewhat more urgent attention than most "new" schemes.

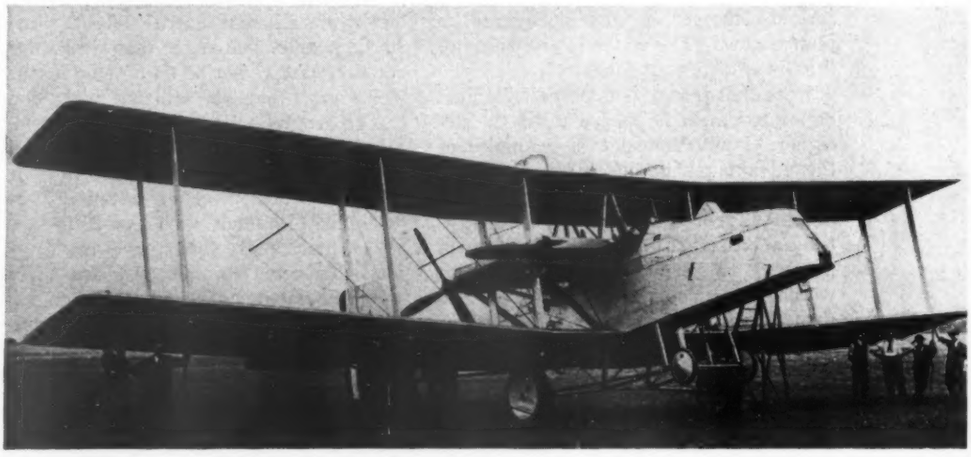
If, for some cause or other, there had never been any landplanes and all airplanes had to operate off the water, the remote drive would have been commonplace long ago, because it would have been found that the engine and the propeller could not efficiently go in the same place, and the problem would have been dealt with accordingly. As it is, the whole flying boat family has suffered in efficiency through being forced to inherit the existing simple and—so far—adequately efficient installation developed for landplanes.

On rare occasions reasons have been found and accepted for profitably taking the propeller away from its usual lodging on the engine. The *Airacobra* is a prominent modern instance; in the Curtiss-Wright Amphibian, which I produced several years ago, a shaft was used to permit the streamlining of a radial engine for pusher operation. But such cases have been infrequent, and have mostly been frowned upon at birth.

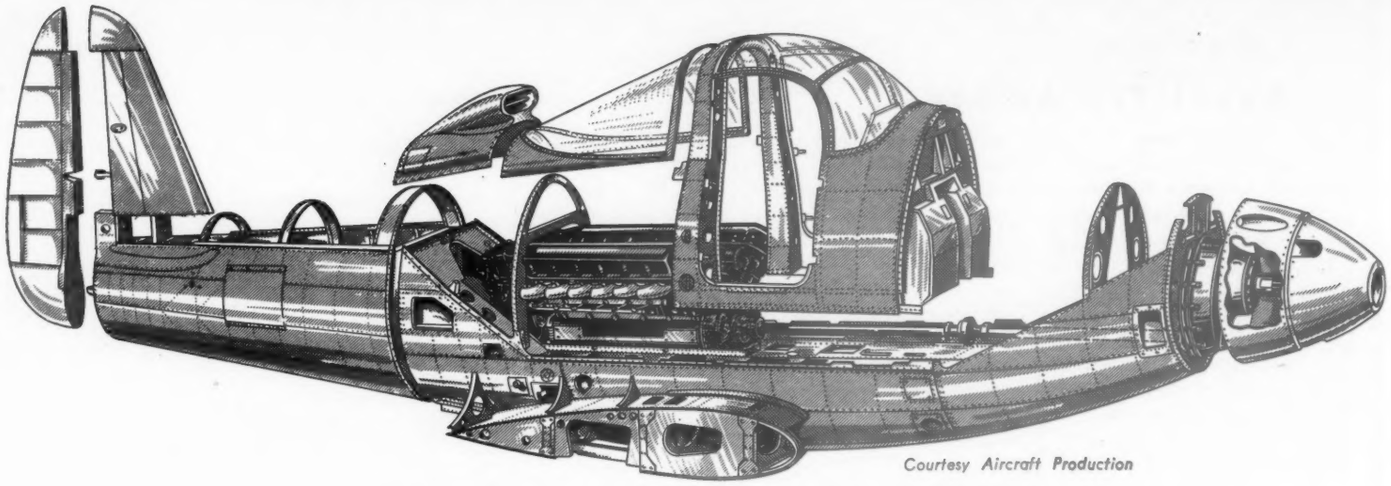
But now a new situation is arising of great consequence. The speed of sound imposes certain limitations on the air propeller, limitations which increase with altitude. It is becoming more and more difficlut to absorb, in one propeller, the steadily increasing horsepowers coming out of one engine. Various plans are proceeding for dealing with that problem; we hear more about four blades, six blades, multi-blades and counter-rotation. All these help to some extent, but to a smaller and smaller degree, and over smaller ranges of performance, as engine horsepowers increase. These propellers are a major development in themselves, their prospective value is questionable, yet it can fairly be said that they are merely stalling off the day when one propeller can no longer be effectively used. It will then become necessary to drive more than one propeller from one engine.

And there, whether you like it or not, is your remote drive.

Now, even at today's maximum powers, the advantages obtainable from



***Above: The Boulton & Paul Bodmin, which featured two-bladed tractor and four-bladed pusher propellers driven by shafting and bevel gears from the engines amidships. Capt. Courtney conducted the flight tests on this early design incorporating remote propeller drives. Below: This is the first official photograph of the Napier-Parnall Possum triplane, which was described in the early twenties as "the latest hush-hush plane completed by the Air Ministry." Two propellers mounted on the middle wing were driven by a single engine.***



Courtesy Aircraft Production

***Modern version of the extension drive as incorporated in the Bell Airacobra. The 10-ft. shaft transmits the drive from the engine aft of the pilot to the reduction gear in the nose. When installed, the shaft is supported in a central bearing.***

driving two propellers from one engine are attractive enough. True, that means undertaking the development of means for connecting the propeller with the engine, but is that greatly different from the work which is continually going on in engine development? And anyway, is it going to take much more time and effort than is required to develop new types of propellers for stopgap purposes only? The stock argument about transmission weights will not survive serious study. So why not take the plunge now? The water is probably not nearly as cold as it looks.

Once that plunge is taken, a wide field of improvement is opened up to the designer. I will not suggest examples of the advantages to be obtained because the difference between pipe-dreaming and intelligent anticipation is not always fully appreciated. But one may point to the high efficiency and flexibility with which power could be converted into thrust and the locating of the engine where its aerodynamic shape is unimportant and its accessibility great—the only limitations being those of a practical transmission. And, not least of all, wings will really get a chance to be wings.

### OBJECTIONS TO REMOTE DRIVE

Up to now the principal objection to remote drives has been that the prospective advantages did not outweigh the cost and effort involved, and that *has been* sound enough, at least in most cases, although that same argument has prevented several worth-while developments on special lines.

But if this argument is carried to the point of objecting that, if remote drives are generally adopted, they will throw much existing conventional design into the waste basket, then that is an argument against progress and is invalid. There is a tendency that way, and it takes the form usually of criticisms based on plausible but unconsidered grounds. The commonest of these is the matter of the *weight* of the transmission, so it is worth some attention here.

The usual, and surprisingly widespread, fallacy is to take the weight of some sample airplane or engine, add to it the prospective weight of so many feet of transmission, and then point out how much efficiency must *obviously* be lost with all that extra weight. Just so did people once argue that steel ships could *obviously* not be built since it was well known that iron will not float. You can go around a modern airplane and fill a large sheet of paper with a list of fittings or features which, at one time or another, were rejected because they "weighed too much"; most of them now weigh much more than they were originally expected to, but they are there just the same, the reason being of course that, directly or indirectly, their contribution to performance more than justified their weight.

In some of these cases, such as the controllable-pitch propeller, the weight could be directly measured against the extra horsepower permitted. In others, such as retracting landing gears and wing flaps, their contribution could not be so accurately measured since, structurally and otherwise, they were mixed up with other features. In still other cases, such as wheel brakes which limit landing-run, their contribution was there, but it could hardly be measured in terms of horsepower. Most of them, though adding weight in themselves, save weight directly or indirectly somewhere else—which, in fact, is principally why they add to performance.

***So to talk about a propeller transmission in terms of weight per horsepower of the engine to which it is attached just does not mean anything,*** except for comparison with some other transmission on the same job.

Actually, with such remote-drive layouts as I have been connected with, it was a question whether any weight was added at all. In the Curtiss-Wright Amphibian the center section did duty for most of the engine mount, largely offsetting the weight of the extension shaft. In two other projects, in which an engine in a boat hull drove a propeller through shaft and bevels, the transmission weights were estimated by such competent authorities, respectively, as Wright and Rolls-Royce; and such were the savings to be estimated from engine mounts, supports, cowling, controls, reduction gear, fuel lines and such details that only the finished job could have shown whether there was not a net profit in weight. So the aerodynamic gain was pure profit.

Of course, there are many instances where a transmission would show no real profit, but that is no reason why it should be condemned in cases where it would. For instance, many years ago I did a lot of flying on the Boulton & Paul *Bodmin*, which had two engines in the fuselage driving four propellers through shafts and bevels. But the idea was not much concerned with aerodynamic improvement—there wasn't much that the burial of a small engine could have done for the built-in headwinds of that day; the scheme was to provide flight accessibility for the less reliable engines of the period. We never had any trouble with the transmission, but the purpose was just not worth the weight. About the same time I flew the Parnall triplane with a similar single-engine and two-propeller arrangement, with similar results. But even as long ago as that, these machines demonstrated that remote drive was practicable if it ever become profitable.

Another objection to the study of re-

mote drives goes something like this: engine cross-section per horsepower is becoming so much less in the larger engines that now the engines are hardly of any more frontal area that the spinners of the propellers they have to turn; so how can you lose by letting the engine occupy the inefficient area of the propeller disk? This argument is plausible, but does not stand up well under analysis. It makes no allowance for the problem of absorbing the large powers on which the argument is based, it insists that the propeller must go wherever the weight of the engine must go, it confuses drag and its various implications with cross-section area, and it tries hard to make a virtue of its own propeller inefficiencies.

It seems to me that the only sound and practical argument against remote drives is this: We have enough trouble without remote drives and we are getting along fine without them; so why bring that up? Definitely, this is a sound argument, because there are lots of things designers would like to do if they had a chance to. All I am asking, however, is: How long can that argument stand up?

### FORMS OF TRANSMISSION

I suppose prospective transmissions of power from engine to propeller are confined to three forms: (1) Mechanical, through shafts (flexible or otherwise) and gears or universals, (2) hydraulic, (3) electric.

I provisionally dismiss electrical drives on grounds of comparative weight. I say "provisionally" because it is dangerous to turn down anything these days. Electric transmission is used on ships, buses and trains; perhaps some electrical engineer can show that it is equally feasible on airplanes.

As regards mechanical transmission, straight-line or parallel transmission is now an accepted practical arrangement. The case of the *Airacobra* is now too well known to need discussion. Many years ago, before the subject was as well studied as it is today, Bellanca had a much longer transmission to a pusher propeller, with little or no trouble to that particular part of the job. Dornier some time ago standardized a considerable extension shaft to a pusher engine, even having the courage to tilt the whole installation for water-clearance at the take-off. If remote-drive development does manage to go through some evolutionary stage, it will probably take the form of a gradual increase in the number of designs in which a pusher propeller is connected by a straight-line extension shaft with a forwardly supported engine. This will almost inevitably involve forced-draft cooling for the engine, and why there seems to be so much fear of having to do that I cannot imagine.

Of recent years methods of measuring and controlling torsional vibrations have been so greatly improved that highly competent engineers on those lines have told me that any reasonable transmission can be devised with every assurance of structural safety.

Those who have brought themselves, with an effort, to concede straight-line drives still seem to kick when it comes to taking the drive round corners. They say, in effect, "Ah! But *that* is different." The automotive engineers tell me it isn't different; it may require more study, more design or more weight. It also opens new possibilities of study as to whether bevels, universals, or some other way is the best for taking the power round a bend; but it is pretty much standard stuff even where the flexibility of the aircraft structure has to be taken into account.

Belt or chain transmission is cheap and simple but, on grounds of aerodynamics and weight, seems to be applicable only to low-powered installations.

I have seen some ingenious-looking proposals for torsion-cable transmissions, with peculiar possibilities for going round bends, but I am unable to find that much serious experiment has been made on them or that any useful data is available. Possibly it is a line worth looking into.

At present the torsion shaft appears to hold the field of mechanical transmissions.

As regards hydraulic transmission, not so much is at present known, largely because there has been little experience of transmission in the powers concerned. However, it is not difficult to see that a successful hydraulic transmission system would offer immense installation advantages and much more besides. Because one other requirement for maximum propeller efficiency is that of variable speed in addition to the other variations required of the propeller, and it has so far not been practicable enough to introduce this into existing installations. With hydraulic transmission this can relatively easily be an integral part of the system.

The problem, then, is that of weight and mechanical efficiency. As to weight, I have heard it claimed that this must inevitably be excessive since (as in the electrical case) the power must first be put into one hydraulic motor, taken down a line, and then be reproduced in another hydraulic motor at the propeller. This is so, but it is not inevitable that these motors must be comparable in weight with the prime motor; if the hydraulic motors, for example, are working at a pressure of 2,000 psi., they become two-stroke motors working at that m.e.p. There is little reason, therefore, why their weight should not be reasonable, especially when that weight includes both reduction and variable-speed gears, and when the weight of installation is considered.

As to efficiency, there is little past experience available, but again there is no reason to assume that a hydraulic gear, dealing with high powers, should suffer from the same degree of power-loss as smaller gears—the reverse is to be expected. In the case of mechanical gears, there is enough experience available to show that the efficiency loss is extremely small; the loss in hydraulic gears is likely to be considerably higher

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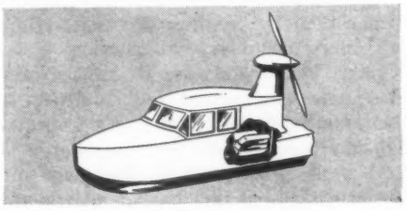
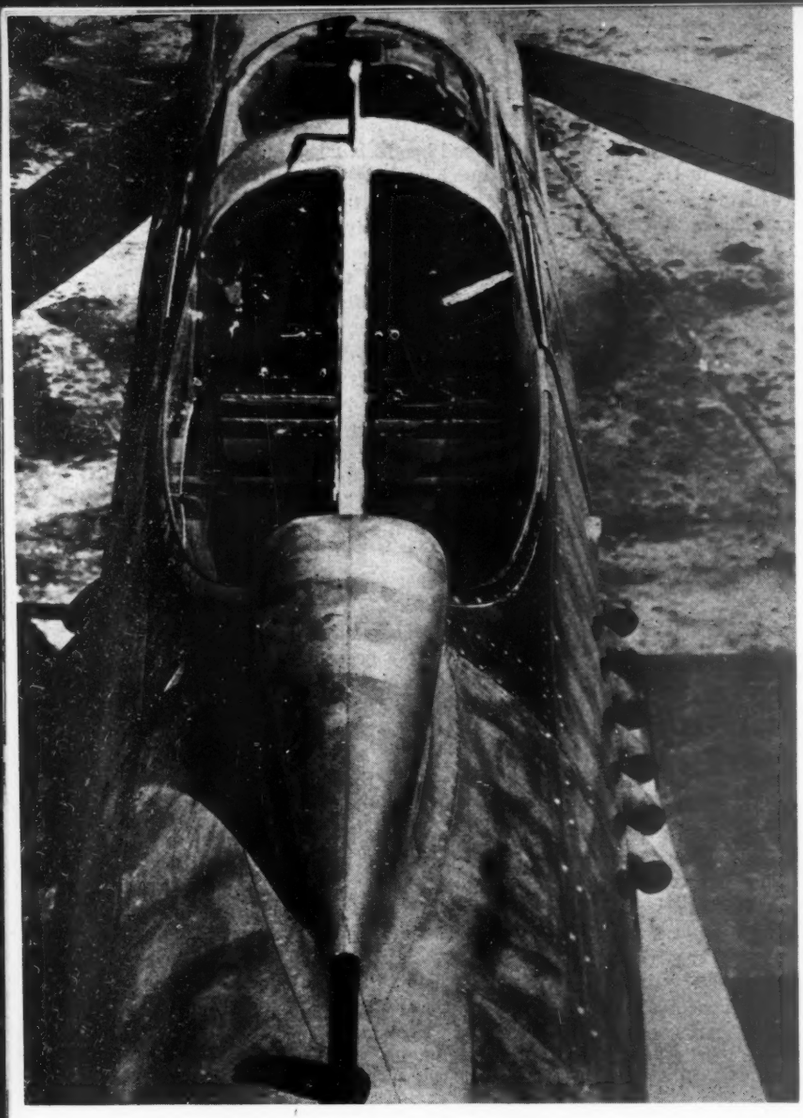


***This arrangement, suggested by Dwight Huntington a decade ago, places the engine in a logical, easily accessible location and transmits power to the point of maximum propulsive efficiency in a design for a light flying boat. (See AVIATION, December, 1933, p. 366.)***

***The four-engine Dornier DO 26, originally designed for trans-ocean operations, utilized extension shafts from the rear engines to the pusher propellers. Each of the rear engines and propellers, as units, tilted upward during take-off to clear blade-tips of the spray.***



*Typical Plexiglas installation on a Bell* Aircobra. *The transparency of acrylic sheets is strikingly demonstrated.*

# Working Transparent Plastics

By JOHN SASSO, *Product Engineering*

**PART I. In this first of two articles are discussed the general characteristics of and methods of forming and joining acrylic plastics sheets for aircraft installations. The second part, appearing next month, will discuss the machining and finishing of transparent aircraft sections.**

SINCE THEIR INTRODUCTION, in 1936, cast acrylic sheets have been widely used by the aircraft industry for cockpit enclosures, tail assemblies, gun turrets, nose sections, observation domes, landing light covers and other transparent parts. The characteristics of these sheets are particularly vital in air craft design; they are strong, light in weight, and crystal clear. Compared to glass, they are less than half as heavy, much stronger, more transparent, and just as permanent.

Sheets of this material can be cut with ordinary saws, machined and drilled with usual metal working tools and—an important advantage—they can be formed to almost any shape at relatively low temperatures.

Acrylic resins, from which these sheets are cast, are derived by a complicated chemical synthesis from petroleum, air and water. They are members of a group of acrylic and methacrylic acid derivatives first studied by Dr. Otto Röhm in 1901. They range in consistency from soft, semi-tacky liquids to tough thermoplastic solids. Variations are produced by manufacturing control rather than by addition of plasticizers. No fillers are used with acrylics. Experience with installation of transparent plastic sheet in aircraft has emphasized the importance of certain design fundamentals. Methods of installation* have been devised to take advantage of the properties of this type of plastic to increase its usefulness in aeronautical design.

An examination of the properties of acrylic resins makes it obvious why transparent plastic sheet material has rapidly replaced glass in many applications. For example, the specific gravity of Plexiglas, an acrylic resin widely used in aviation, is 1.18 to 1.19 as compared with approximately 2.5 for glass; and it is 91 to 92 percent efficient in transmitting light as compared with 88 percent for glass. However, it is thermoplastic and can be shaped when treated. Two- and three-dimensional curved sections may be obtained for turret and cockpit enclosures which conform to the streamlined design of the rest of the plane. The high impact strength of the acrylic resins also obviates the necessity for cumbersome braces and supports which might obscure visibility.

Sheets of Plexiglas are masked with tough paper when received from the manufacturer to protect its high polish which, because of the extreme clarity of the plastic, will show slight surface scratches. A further advantage of masking is that it allows a layout to be drawn on the paper from a template; and, when the piece is not to be formed, the masking will continue to protect the surface until installation is complete.

Size, shape, and service required of the window or enclosure are considerations that affect the size and type of

* See AVIATION, March, 1942.

frames for holding the transparent sections in place. All flat sections and simple curved sections can generally be installed in channels without drilling holes through the material. Although landing-light covers may be curved to an arc of more than 45 deg., they can also be set in simple channels. These sections are formed to follow the contour of the leading-edge of the wing.

### FORMING ACRYLIC SHEETS

Since they are thermoplastic, acrylic resin sheets become soft and pliable when heated to 220-300 deg. F. and they can then be bent to almost any shape. When the material cools it retains the shape to which it is bent, except for a small contraction caused by the lowering of temperature. Formed material, however, has an "elastic" or "plastic memory" and will revert to its original flat shape when reheated to the forming temperature.

It is not practical to cold form or spring the material into a curved frame without heating unless the material is thin and the curve slight. For example, a 16 in. piece, 0.250 in. thick, should not be deflected more than ¼ in. The outer fibre stress on a curved cold formed piece may cause tiny fissures called "crazing." Hot forming is simple and eliminates crazing in curved sections; it is by far the better procedure.

Strains can be kept to a minimum by making sure that the material is thoroughly heated before forming. Complicated shapes require somewhat higher temperatures than simple curves.

On the other hand, when too hot, the surface is too soft and too apt to pick up minor imperfections from the form. Fingerprints, glove marks and specks of dirt can make a deep surface impression, requiring extensive polishing later.

Probably the best compromise is to heat 15 or 20 min. at the proper temperature, then to allow the surface of the blank to cool a minute or two before letting it come in contact with the form. With experience, the satisfactory degree of pliability can be determined by feeling and twisting the edge of the sheet.

The application of high or even moderately high pressures is neither necessary nor desirable in forming, since it tends to increase the extent of mark-off. The power required to form is much less than that required for soft metals. The heated material can be handled like a sheet of pure gum rubber and approximately the same power is required to stretch it. For simple shapes, especially with thick sheets, the weight of the material is usually sufficient, and only if considerable stretching is involved should much pressure be applied.

Contour tolerances of ±0.125 in. can be maintained in most forming operations, but for three-dimensional sections with a deep draw, greater latitude should be allowed.

### HEATING

Ovens heated by steam, electricity or gas have been found most satisfactory for Plexiglas. The temperature should be kept within the 220 deg.—300 deg. F. range by adequate control equipment and circulating hot air inside the oven.

The sheets may be hung vertically in the oven or placed on trays with cloth bottoms. The sketch shows a possible oven arrangement.

Remove all masking paper before heating for forming. Then rinse with distilled water, or, if tap water is used, dry thoroughly by blotting with soft tissue paper. Any solids in ordinary tap water will bake into the surface if this precaution is not taken.

Boiling water is not satisfactory, except for very thin material, for two reasons: first, it is not really hot enough and the addition of salt or glycerine to the water does not raise the temperature sufficiently. Second, water may be trapped between the sheet and the form. If this water vaporizes, it may cause cloudy "steam spots" on the material.

Hot oil baths are more satisfactory and relatively easy to set up. Their temperatures are high enough and remain fairly constant. If the oil is clean, it does not affect the surface. Oil, however, makes the material difficult to handle and adequate provision must be made for the inevitable dripping and splashing.

### FORMS

Since most forms are not subjected to great pressure, they may be made of material as brittle as plaster. The choice between plaster, wood, metal, masonite and combinations of materials, therefore, depends on considerations of cost and length of expected service. For simple two-dimensional bends, metal, masonite or plywood forms are easily made; for more complicated shapes, plaster forms are easier to make and perfectly satisfactory. It is usually advisable to reinforce the plaster with wire and to use strips of metal at the edges—especially for stretch forming where there may be considerable pressure on the edges.

The form should be somewhat larger than the finished piece. This permits the use of slightly oversize sheets, which simplifies handling and which compensates for the slight tendency of the Plexiglas to curl away from the form and to flare at the edges. It is helpful to mark a "trim line" on the form, indicating the limits of the finished piece.

The form should be free of waves and

*Typical oven for heating acrylic sheets before forming.*

### TABLE OF PROPERTIES

Since PLEXIGLAS is a thermoplastic, the properties will be found to vary with the temperature of the material. The values given apply for 25° C. to 30° C. (77° F. to 86° F.).

#### Optical Properties

| | | |
|---|---|---|
| Clarity | Light Transmission | 91–92% |
| | Scattering Effect | Practically nil |
| Refractive Index $N_d$ | | 1.488–1.489 |
| Dispersion | | .008 |

#### Physical Properties

| | |
|---|---|
| Specific Gravity | 1.18–1.19 |
| Hardness Mohs | 2–3 |
| Vickers | 18–20 |
| Brinell | 18–20 (500 kg. 10 mm. ball) |
| Tensile Strength | 7,000–8,000 lb./sq. in. |
| (Elongation at failure) | 5–15% |
| Flexural Strength | 14,000–16,000 lb./sq. in. |
| Compressive Strength | 10,000–12,000 lb./sq. in. |
| Impact Resistance | 0.3–0.5 Ft. lb. (ASTM Charpy notched bar) |
| Modulus of Elasticity | 4–6 x $10^5$ lb./sq. in. |
| Coefficient of Expansion | 8 x $10^{-5}$/° C. |
| Water Absorption by Weight | |
| 24 hours | 0.3% |
| 48 hours | 0.4% |
| 500 hours | 1.2% (Equilibrium) |

#### Electrical Properties

| | |
|---|---|
| Dielectric Constant (60 cycles) | 3.4 to 3.6 |
| (1,000,000 cycles) | 2.5 |
| Power Factor (at 60 cycles) | 5 to 6% |
| Volume Resistance | $10^{15}$ ohms/cm³ |
| Dielectric Strength (short time test) | 500 volts/mil. |
| (one minute stepwise) | 400 volts/mil. |

#### Chemical Properties

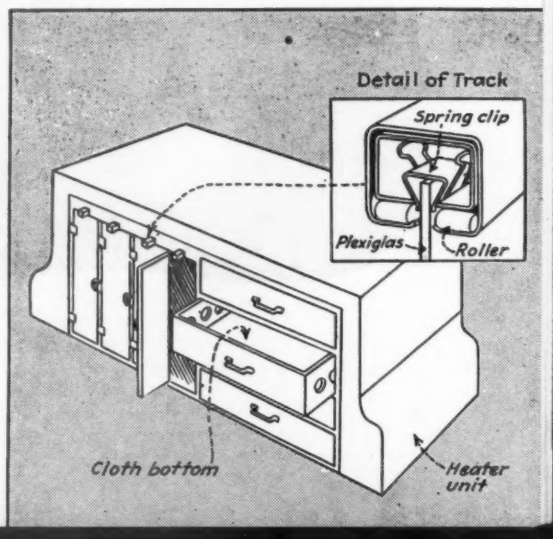
*(Approved test of the Committee on Plastics of the American Society for Testing Materials.)*

Pieces of PLEXIGLAS 1" x 3" x .125" were totally immersed in the following twelve chemical solutions for 192 hrs. at 25° C. and the absorption measured.

| Immersion Solution* | Percent Weight Gain |
|---|---|
| 30% Sulfuric Acid | 0.6 |
| 3% Sulfuric Acid | 1.0 |
| 10% Hydrochloric Acid | 0.7 |
| 10% Sodium Hydroxide | 0.8 |
| 1% Sodium Hydroxide | 1.0 |
| 10% Nitric Acid | 0.9 |
| 5% Acetic Acid | 1.0 |
| 2% Sodium Carbonate | 1.0 |
| 10% Sodium Chloride | 0.9 |
| 10% Ammonium Hydroxide | 0.9 |
| 3% Hydrogen Peroxide | 1.0 |
| 100% Distilled Water | 0.9 |

* All concentrations given in % by weight in distilled water.

A gain in weight of 1% or less is considered negligible except in unusual applications. None of the above solutions appreciably affect the appearance or strength characteristics of PLEXIGLAS.



# *Eyes in the Night—*

SOME people might call night flying "blind flying."

But to the skilled pilot it is flying with *eyes* that see through night as well as shining day.

These *eyes* are radio and precision instruments — sensitive altimeters, direction indicators, vertical and air-speed indicators, to name a few.

Such precision instruments are Kollsman's contribution to the fighting efficiency of combat planes of the United Nations . . . and to the safe, dependable operation of the transport planes of the nation's scheduled Airlines . . . the efficient Air Transport system that weaves the entire nation into a neighborhood — and speeds precious war-production man-power and cargo to destination in a matter of hours . . . not days or weeks.

other variations in contour which might cause optical distortions. The surface should be sanded smooth and covered with soft cloth (such as billiard felt, outing flannel or imitation chamois) or flocked rubber or suede rubber sheeting. Forms should be kept clean and brushed off before each piece is formed.

In many cases, pieces can be best formed by using a hold-down ring or yoke, fitted to the mold but allowing for the thickness of the sheet between the mold and the ring. This ring should be hinged or otherwise attached to the form so that it will fit exactly when pressed down on the hot steel. Stops should be arranged to prevent the ring from being forced into the material when pressure is applied. This hold-down ring may be the exact size and contour of the piece; so that when cooled the piece may be scribed, on the form, around the inside of the ring. Contraction on cooling may be large. The use of a hold-down ring prevents curling away from the form and also permits use of smaller blanks to obtain the same size finished piece.

If there are form marks or mark-off on the surface, the sheet should be put back in the oven. It will resume its flat shape—and its original surface except for scratches—and can then be formed again. It is more economical to re-form several times than to sand and buff out mark-off.

### STRETCH FORMING

Many three-dimensional shapes can be made by stretching across a form. The material is heated slightly hotter than for simpler forming, but the surface allowed to cool slightly, as usual. During this cooling, a number of wooden carpenters' clamps are fastened to the edges, six to ten inches apart. Holding these clamps, a circle of men draw the sheet down around the form. A metal ring can then be clamped in position around the edges.

### MALE AND FEMALE FORMING

For three-dimensional sections, especially sections of irregular contour, male and female forms may be used, but the method is not recommended. The hot sheet is stretched across the top of one form usually the female, and held in position by hand or with clamps while the other form is lowered into place. In this method, a long cooling time is required because heat does not dissipate quickly.

The basic objection to this type of forming lies in the fact that both sides of the sheet come in contact with mold surfaces and both are therefore subject to mark-off. This mark-off is often quite severe and may require extensive sanding and polishing. Mechanical or hydraulic presses should not be used. The pressures thus developed are in excess of those required, and poor optical properties will result.

### CEMENTING

It is possible to obtain a cemented joint closely approximating the original sheet in strength and transparency. These directions apply specifically to cementing two pieces of Plexiglas together. For cementing to metal, to glass, to wood, or to other materials the following methods may be followed, but it is usually preferable to use a solution of acrylic resin in an organic solvent.

### TYPES OF CEMENT

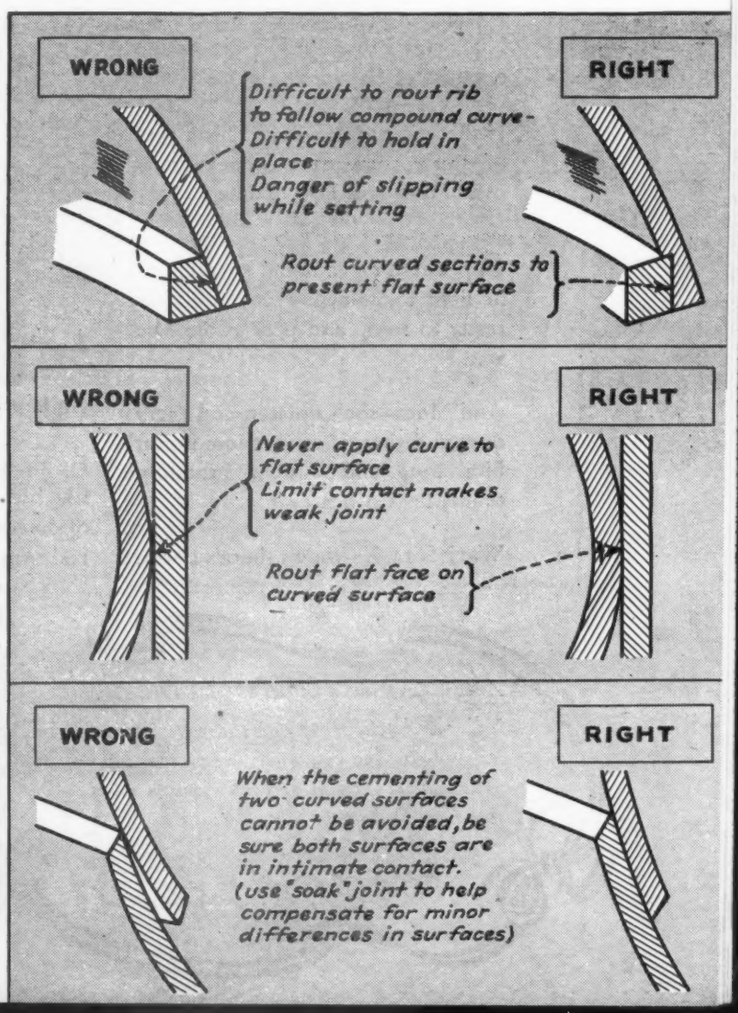
Four types of cement may be used in cementing Plexiglas to Plexiglas, each offering specific advantages in particular applications:

1. Monomeric methyl methacrylate closely related to the liquid resin from which the sheet is originally cast; and the same process, polymerization, by which this liquid becomes solid, is made to take place in the cementing procedure.

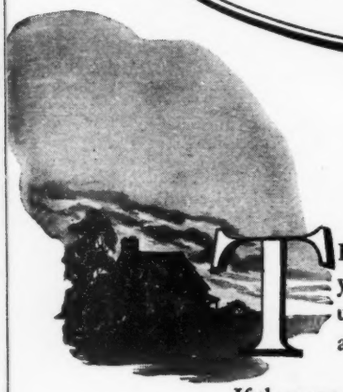
Since heat, light and air act to hasten

*Inspecting a newly formed Plexiglas section at the Bell Aircraft Company plant.*

*Right and wrong methods of joining curved surfaces. If possible, cementing of curved surfaces should be avoided.*


WRONG
RIGHT
Difficult to rout rib to follow compound curve - Difficult to hold in place Danger of slipping while setting
Rout curved sections to present flat surface
WRONG
RIGHT
Never apply curve to flat surface Limit contact makes weak joint
Rout flat face on curved surface
WRONG
RIGHT
When the cementing of two curved surfaces cannot be avoided, be sure both surfaces are in intimate contact. (use "soak" joint to help compensate for minor differences in surfaces)

# "By the Dawn's Early Light"



THE first low ray of the young morning lights his untroubled face, peaceful and serene.

If there are dreams behind the closed eyelids, they are boyish dreams of bikes and BB guns and the heroic exploits of Superman.

If there is concern here, it is a sort of puzzlement over what's come over Mom and Pop of late . . .

Pop doesn't get home so early as he used to, somehow isn't quite as ready to romp and play as once he was.

And Mom—she's quieter, and every now and then is caught looking at him, long and slow, a brooding tenderness in her eyes.

War? Sure, he knows there's a war. It's in the headlines, names of far-away lands, unreal as any fairy tale.

Pop says they can't get new tires for the car because of the war; and instead of giving him nickels now and then to spend, brings home War Savings Stamps that he says will be spending money "after the war's won."

But what's all this got to do with a little boy?

He doesn't know, of course, that even while he sleeps here in the dawn's early light, somewhere soldiers, sailors and airmen stand vigilant guard – for his sake.

He doesn't know that while kids like him play their shouting games of dive-bomber and mock air alarm, real American planes are splitting the sky, real American bombs are arrowing to their targets, real American machine guns are chattering forth destruction – for his sake.

He doesn't know that vast factories hum in angry haste through seven three-shift days a week – that to help America reach its goal of 60,000 war planes this year, plants like Goodyear Aircraft are pouring forth countless airplane wings, tails, nacelles, stabilizers, wheels, brakes and other subassemblies – for his sake.

He doesn't realize, you see, that *he* is the coming America.

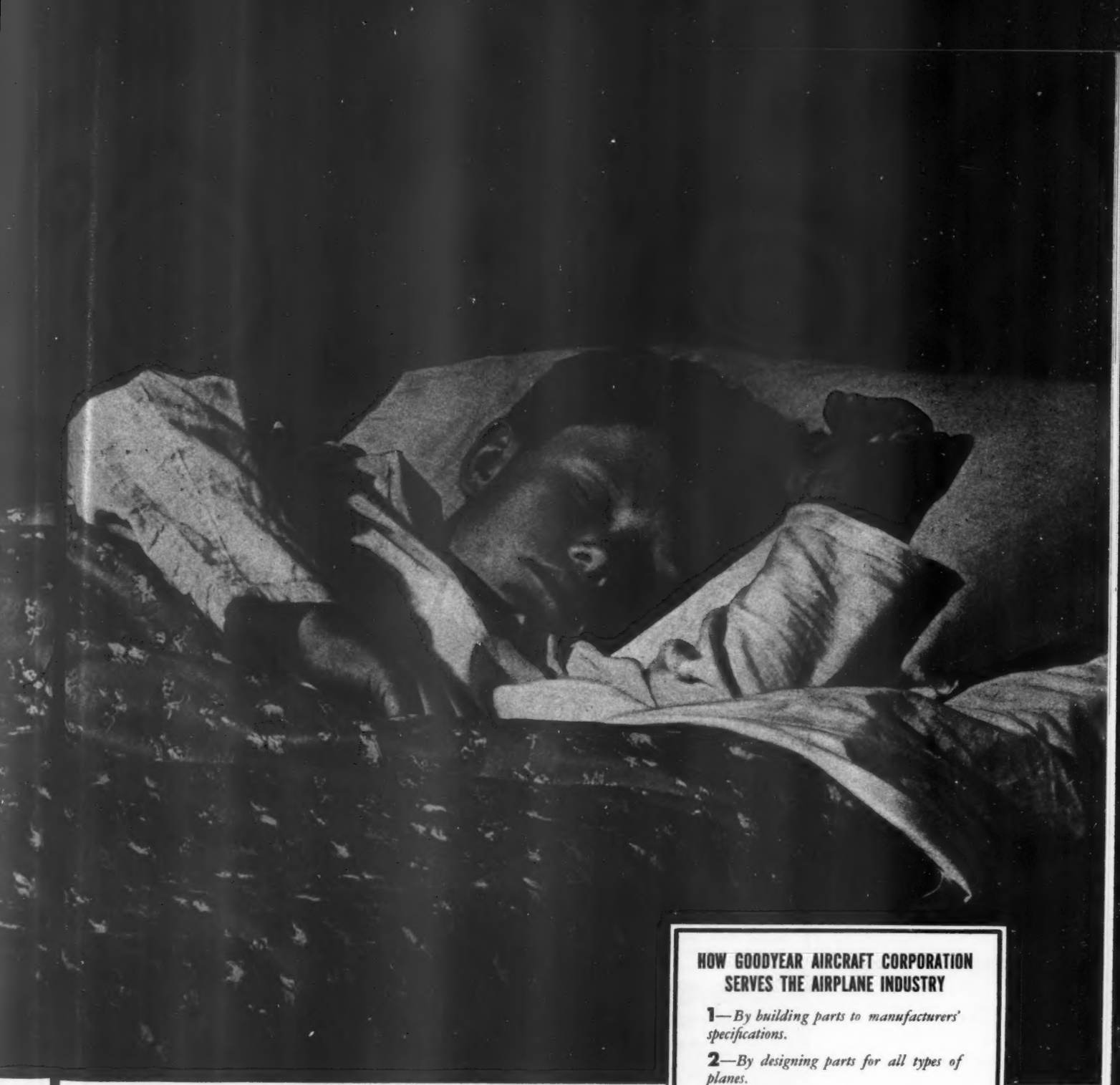
He doesn't know *he is the future,* here with us today, living emblem of the one thing in the world worth fighting for – hope, and promise, the chance for a better life.

He doesn't know that as long as

*AMERICA MUST BE FIRST IN THE AIR*

*Unless and until America is the most powerful nation in the air, our safety, our freedom, and our standard of living will not again be what they have been in the past.*

P. W. Litchfield



boys can be boys, men can be *men* – that Mom and Pop understand that, as he will himself some day when he has a son of his own.

It won't be the billions we spend that will win this war, not all our factories and the machines that are in them – it will be the things men see in the faces of little boys.

It will be the willingness of fathers not only to fight, but to work and sacrifice in fierce guardianship of those they love.

So may his sleep be sweet.

Some day he'll take up the burdens, the fruitful tasks of manhood; it is our job now to see that he can take them up as a free man, fit to fashion a better world.

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**2**—*By designing parts for all types of planes.*

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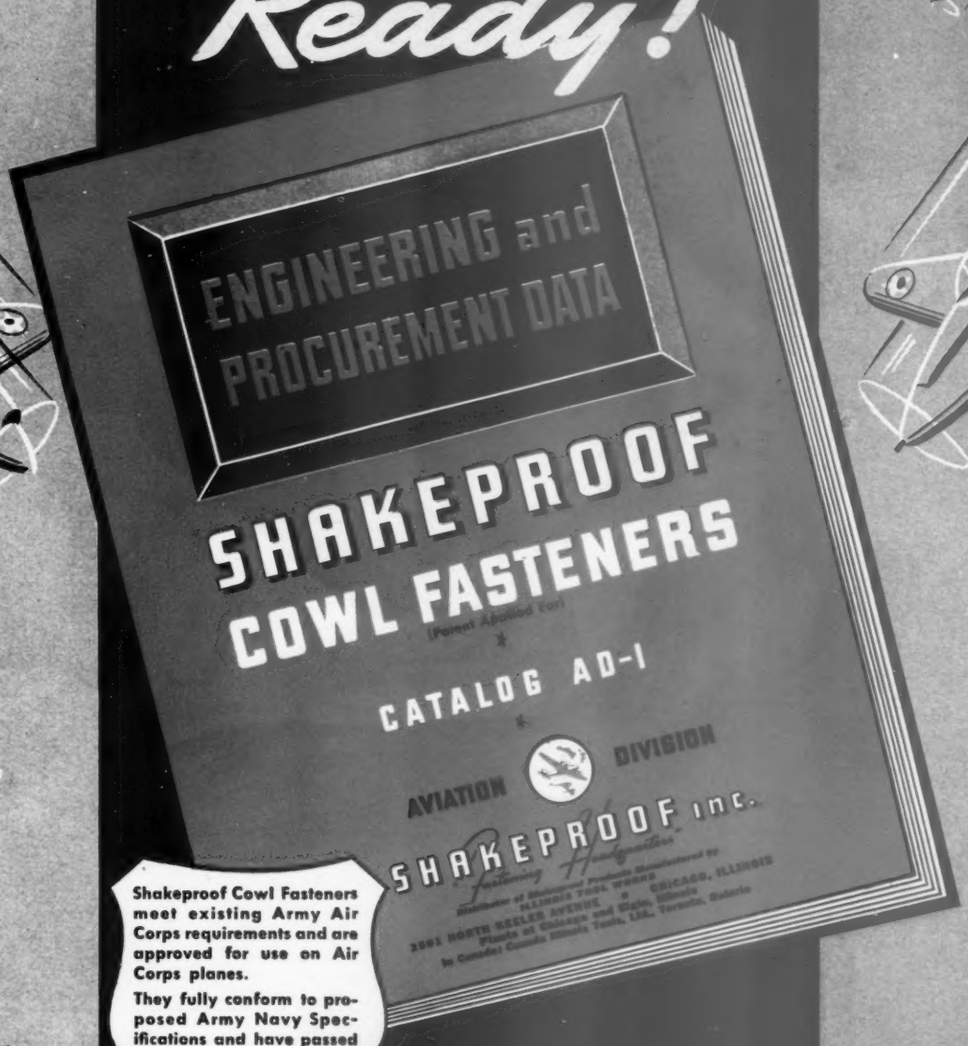


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**They fully conform to proposed Army Navy Specifications and have passed official Air Corps tests.**

## *Features*

- Reinforcing structure
- No stress hazard
- Limited deflection with full support
- Compensation for variations in sheet thickness
- Automatic stop for cross pin
- Visual identification of closure
- Maximum axial float for stud
- Easy alignment
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Shakeproof has developed an improved Cowl Fastener for Aircraft which incorporates great strength with quick and easy locking and unlocking. The features of this unit listed at the left are fully explained in the new 28-page catalog AD-1 which contains complete engineering and procurement data, including a detailed test report on the physical properties of this fastener. Write for your copy today!

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Plants at Chicago and Elgin, Illinois
In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

View of Shakeproof Cowl Fastener assembly in locked position.

View of Shakeproof Cowl Fastener assembly in unlocked position—two sheets separated.

SEMS FASTENER UNITS • LOCK WASHERS • LOCKING AND PLAIN TERMINALS • THREAD-CUTTING SCREWS • LOCKING SCREWS
SPRING WASHERS • RADIO AND INSTRUMENT GEARS • COWL FASTENERS • SPECIAL STAMPINGS

this process of polymerization, it is necessary to add a chemical reducing agent (hydroquinone) to prevent or inhibit the solidification of the liquid in transit. This inhibited monomer will remain liquid one or two months at room temperature and longer periods under refrigeration.

To counteract the effect of the hydroquinone a second chemical, benzoyl peroxide (supplied in a separate capsule), is added before cementing is begun. After the benzoyl peroxide has been added, the monomer will remain liquid only if kept in a refrigerator.

Before starting to cement, the contents of the benzoyl peroxide capsule are added to a pound of monomer (or use proportionate amounts of each material) and the liquid poured into a large flat enamel pan or glass container. The solid pieces, taped as described below, may then be dipped directly in the liquid. It is often more convenient to rest the edge to be cemented on a piece of felt on the bottom of the pan and barely cover the felt with monomer. The sheet is soaked ten minutes to one hour depending on the depth to which the material must be softened to make a satisfactory joint. After soaking, the excess monomer is removed by waving the piece in the air. The sections are pressed in position and held in place with jigs until the joint is hard.

2. Partially polymerized monomer: The desired quantity of C or monomeric methyl methacrylate is placed in an enamel or Pyrex glass container of about twice that volume and loosely covered. The liquid is brought to a boil on an electric hot plate with frequent shaking. It has a boiling point approximately that of water, but because of its inflammability must be kept from an open flame. As soon as the liquid has been brought to a boil, the flask is transferred to a steam bath and the heating continued until the material reaches a viscosity somewhat greater than that of glycerine.

In process of polymerization, considerable heat is generated, and the flask must be shaken frequently to dissipate this heat. Otherwise, the temperature will build up in the center of the material, causing it to boil over.

When the desired viscosity is reached, the flask is thoroughly cooled with cold water and placed in a refrigerator until the cement is to be used. In this state, the cement may be applied like glue to whichever surface is more convenient.

3. Solvent cements depend on their ability to soften the surfaces, and are used very much like the monomer cement described above. During the "setting" time, the solvent evaporates and the sheet hardens again. Of all solvents, ethylene dichloride is by far the most satisfactory. The use of other solvents, except in emergencies, is to be avoided.

4. Solvent-Polymer cements are made by dissolving shavings in acetone, ethylene dichloride or some similar solvent until a viscous syrup is obtained. If evaporation of the solvent makes the cement too thick, more solvent may be added. The cement is used very much as partially polymerized monomer is used, but its setting time is shorter. A solvent-polymer joint is apt to be more brittle than the other types.

Which cement is used will depend on a number of factors. Partially polymerized cement is usually used for flat sections, and for sections too large to soak, since it is so convenient to apply. Monomer and ethylene dichloride cements are useful when it is difficult to obtain an accurate fit of the two pieces to be cemented. After prolonged soaking, the sheet becomes soft and gummy enough to compensate for slight discrepancies in the fit. Monomer joints are stronger and more reliable than ethylene dichloride joints; but it is, of course, far easier to purchase and to store ethylene dichloride than monomer.

Where the facilities are available and where any considerable amount of cementing is undertaken, ethylene dichloride and partially polymerized monomer would probably be used. In emergency repair kits and in shops where little cementing is undertaken ethylene dichloride is probably preferable.

Because extruded rods are dissolved very rapidly by monomer and solvents, neither is satisfactory for cementing them. Partially polymerized monomer

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**IN THE APRIL ISSUE OF AVIATION there appeared Correct Methods of Plexiglas Installation by Dr. D. S. Frederick which has served to put into the hands of designers and engineers vitally needed information to secure maximum service from this material.**

**Mr. Sasso now makes a further important contribution in his compilation of information relative to the working of transparent plastics prior to installation, and general discussion of the characteristics of these acrylic resin sheets.**

**The second part of Mr. Sasso's article will appear in the next issue. His material, coupled with Dr. Frederick's article, constitutes a complete reference set on transparent plastics in aircraft, from original design through forming, handling and machining, to final installation.**

**The author wishes to acknowledge the cooperation of Röhm and Haas Co., manufacturers of Plexiglas, in the preparation of this information.**

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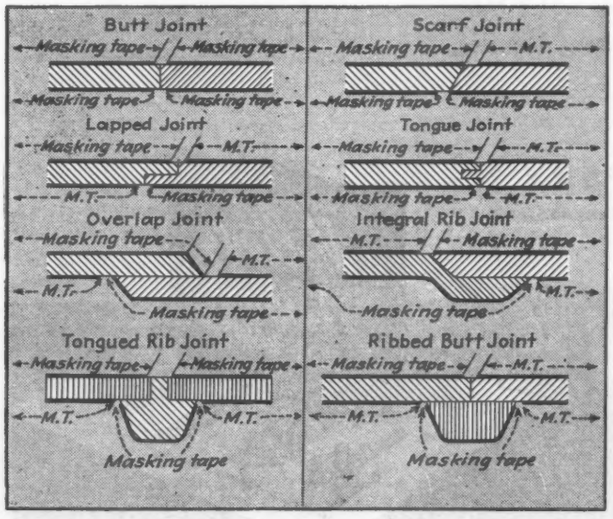
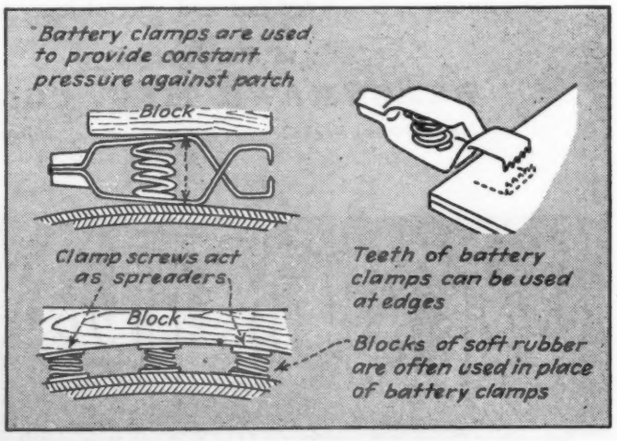




Battery clamps are used to provide constant pressure against patch
Block
Clamp screws act as spreaders
Block
Teeth of battery clamps can be used at edges
Blocks of soft rubber are often used in place of battery clamps

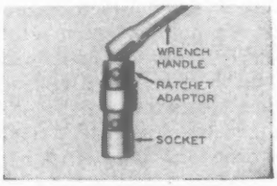
*Left: Taping for different types of joints. Masking tape is applied to within 1/16 in. in "soak" joints, and 1/32 in. in other joints. Below: Cementing clamp details. During first four hours, joints should be kept under constant light pressure—approximately 10 lb. per inch of joint.*

# A LEFT-HANDED MONKEY WRENCH MIGHT NOT HAVE BEEN A BAD IDEA

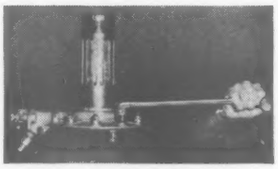
● Listen, Mister, the fellow who originated that "crack" had something. A mechanic with a big-jawed open-end or ordinary wrench has to be a regular-contortionist—the way nuts and bolts are often hidden in the darndest tight spots. Even if he can reach 'em, he can't get a firm hold, so what happens — short, time-wasting bites, rounded nut corners, slips and barked knuckles. But, that's ended now with the modern new-type, quick-detachable *Blackhawk Socket Wrenches.*

## There's a *Right* Blackhawk Socket Wrench to Speed Up Every Job

Blackhawk *interchangeable* sockets, extensions, handles and ratchets give you new and startling developments for speed, safety and efficiency. They click together to make *just the right* combination for proper leverage and clearance on any assembly, service or maintenance job. Save valuable time and eliminate need for many special tools. For the last word on solving nut and bolt problems requiring wrench openings of 3/16" to 3-1/2", call your Blackhawk Industrial Supply Distributor — or write us for free copy of 48-page "HANDY GUIDE," describing the full line-up of 185 sockets, handles, attachments, box-wrenches and specialties.




***New Adapter Makes a Ratchet of Any Socket Wrench Handle***
A typical Blackhawk time and knuckle-saver. Fits in between socket and handle—converts any handle into a fast working ratchet. Used with tension wrenches, hinged offsets and handles, it gets you into cramped quarters, recessed spots and corners where regular ratchets can't work.



***Avoid Injury and Damage from Falling Sockets***
Blackhawk's exclusive, patented Thumb Release "LOCK-ON" feature makes it impossible for sockets to slip or drop off accidentally — to become lost and damage mechanism.

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or solvent-polymer cements should be used. A quick and fairly strong joint may also be obtained by heating the ends of the rods in an alcohol lamp, then forcing them together in a metal clamp.

### PREPARING THE JOINT

For a satisfactory joint, the two pieces to be cemented should fit accurately. In butt joints, for example, both edges should be true and square before starting to cement. It is advisable to rout or sand curved sections to present flat surfaces before cementing.

Where two curved surfaces must be cemented, as in an overlap joint of two curved sections, the curves of both should be of the same radius. Surfaces should have a good machine finish or should be sanded smooth. The surfaces should also be cleaned with methanol (wood alcohol) to remove dirt and dust. Water or dampness may cause cloudiness.

### TAPING

Taping is necessary because both monomer and ethylene dichloride soften the surface and it is necessary to confine this etching action to the area of the joint. The tape used is a tough paper tape impervious to the action of the cement and backed with pressure sensitive adhesive.

When partially polymerized cement is used, the tape is applied as closely as possible to the limits of the joint in a band 1 to 2 in. wide. Be sure there are no air bubbles.

The viscous cement is applied to one of the surfaces to be cemented and the other section, also taped, is placed into position. Enough pressure is applied to remove all air bubbles from the joint, and the whole assembly is clamped in a jig.

In right angle, overlap, and rib joints—wherever there are corners in which the cement can collect—clean the joint carefully after it has set a few minutes under slight pressure. Using a razor blade or other sharp instrument, scrape the excess cement onto the tape and then remove the tape entirely. By working carefully and by cleaning the joint promptly, it is possible to save a great deal of sanding and polishing time putting the joint in order.

When monomer or ethylene dichloride is used in a "soak joint," one section is soaked in the solution—often completely immersed—and must, therefore, be completely protected. The whole piece is taped within 1/32 in. of the proposed joint, a margin being allowed for the softening action of the cement. The piece is soaked in the cement ten minutes to one hour until the surfaces are softened to a great enough depth. Ethylene dichloride will require much shorter times.

Here again the joint should be cleaned just as soon as the section is put in position by scraping excess cement onto the tape and removing the tape.

### JIGS

In most cases, the success of a cementing job depends on the jig holding the two sections in place until the joint is hard.

Excess pressure should be avoided, because of the danger of setting up strains in the joint. The pressure (1) should be enough to squeeze all bubbles from the joint; (2) should be applied evenly all along the joint; and (3) should compensate for the shrinkage which takes place in the joint during setting or hardening.

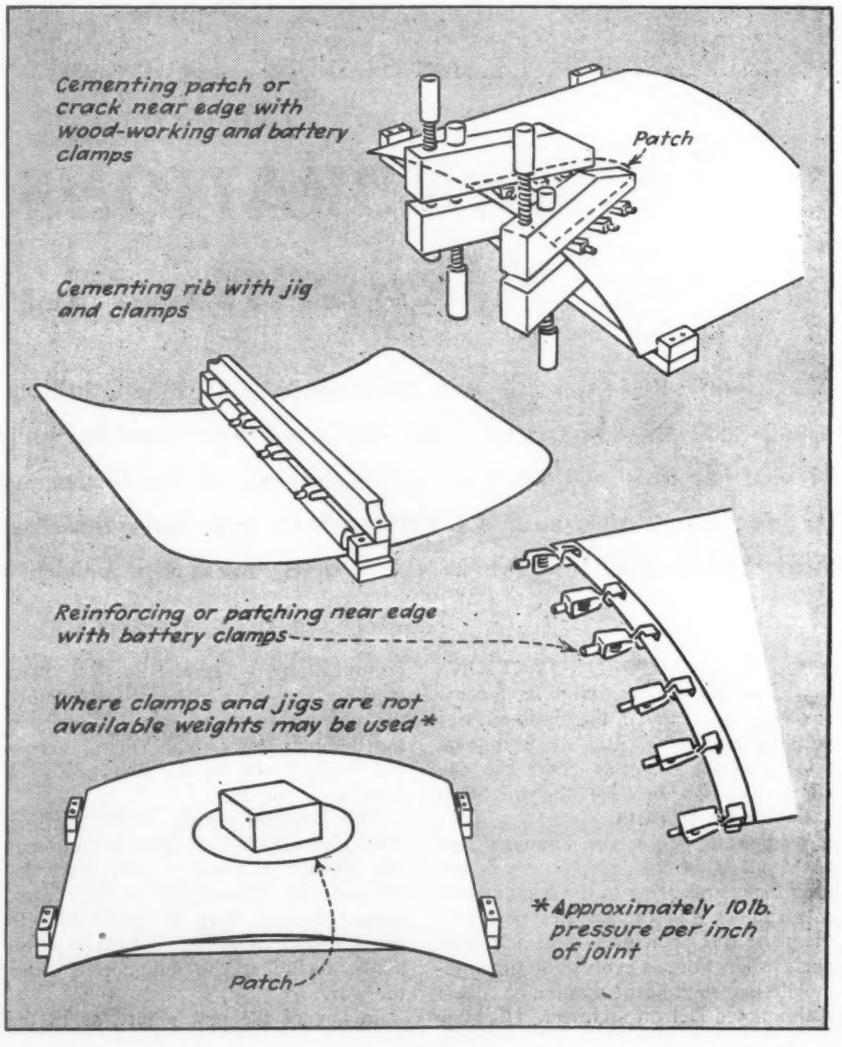
These three conditions are best met by using spring clips (spring clothespins or battery clamps) used in conjunction with jigs. For cementing a rib in position, for example, a jig will be built with a wooden bar directly above the rib. Then, between the bar and the rib, battery clips will be inserted at about 2 in. intervals.

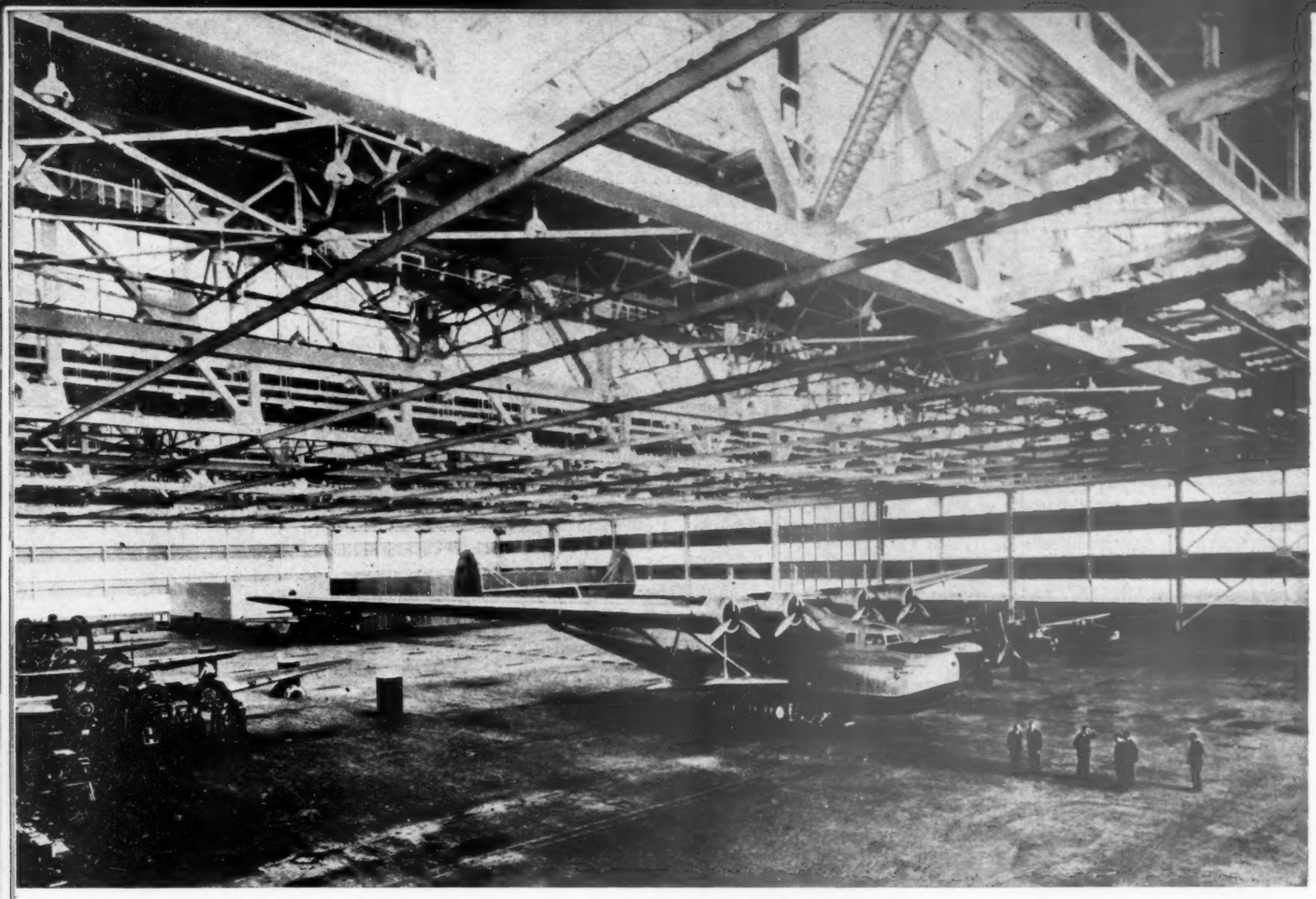
Where small quantities or conditions do not permit the construction of special jigs, weights and springs may serve the purpose.

The joint should be allowed to harden for at least four hours before it is moved from the jig, and another 24 hours should be allowed to elapse before any strain is placed on it. A joint soaked an hour may require as long as three weeks to harden completely. Setting time may be reduced by exposing the joint to sunlight.

The joint must be thoroughly hard before machining, sanding, or polishing. The softened material continues to shrink until it is fully polymerized, and if the joint is trimmed and sanded too soon, a visible scar will be left along the joint.

*Typical jigs for cementing acrylic sheets.*


Cementing patch or crack near edge with wood-working and battery clamps
Patch
Cementing rib with jig and clamps
Reinforcing or patching near edge with battery clamps
Where clamps and jigs are not available weights may be used*
Patch
*Approximately 10 lb. pressure per inch of joint



# INNOVATIONS in AIRPLANE PLANT DESIGN

**Maximum efficiency for the immediate job of producing vast quantities of airplanes, and maximum utilization value for post-war manufacturing is the architectural objective of the day. This article outlines some of the features incorporated in modern mass-production plants such as column-free assembly floor space shown above where 300-foot flat spans, longest in the world, form the bridge trusses supporting the roof.**

**By M. M. VALENTINE**
*Albert Kahn Associated Architects and Engineers, Inc.*

OUTSTANDING INNOVATIONS in airplane plant design have come about as a result of the national war building program. And these innovations are fast bringing closer the day when America will be the mightiest aerial power on earth.

Without a doubt, the foremost new development of the last two years has been that of adapting to the manufacture of airplanes and the engines powering them the best principles of straight-line, mass production, as evolved by the automobile industry, in the opinion of Albert Kahn, noted Detroit architect. His huge organization of specialists has been working at top speed, since even before the defense program was initiated, in the designing of airplane plants across the country and in the supervising of their construction.

The airplane people, while availing themselves of the best ideas the automobile industry has had to offer, have developed real innovations of their own. Some of these may be adopted, with great benefit, by private industries of all kinds, including the automotive, after the war.

In any of the new plants, as in the automobile industry, raw materials enter one end of the building, whence they flow smoothly through the various manufacturing operations in continuous lines, without backtracking, and emerge as completely fabricated units.

Machines are installed in such a way that they can be quickly moved to new locations if a different manufacturing arrangement is found desirable or in

*Above: Designed for straight-line, mass production methods, this plant is complete under one roof, with assembly floor space, interrupted by a minimum number of columns. This layout typifies the industrial architectural trend of the day . . .*

*Below: Through this subway passage plant employees enter and leave the building and take conveniently spaced stairways to specific working positions on the main production floor. Off the underground corridor are air-conditioned cafeteria, lunchrooms, lockers, and washrooms.*

change. There will be a minimum of confusion in the 10 or 15-minute overlap with one shift going off duty and the other coming on, by virtue of the underground corridors, off which are conveniently located huge, air-conditioned, well-lighted cafeterias, designed to feed hundreds of workmen in jig time, and an abundance of locker rooms, washrooms, toilets and other facilities.

While not originally intended as shelters against bomb fragments, these new underground systems will serve admirably as means of protecting workmen in the event hostile aircraft, bent on destruction, come over the plants. The factory floors are of unusually heavy reinforced concrete, supported by extra-massive basement columns.

It is predicted that this new means of entering and leaving airplane plants, because it so increases straight-line production efficiency, will be adopted for many types of industrial units during and after the war. One great advantage of the system is that such utilities as cafeterias, locker rooms and washrooms will never interfere with future expan-

the event expansion of the plant becomes necessary.

All the new airplane plants are so planned and located that expansion can be carried forward without interference with existing production. Power plants, storage buildings and other structures have been placed so as not to stand in the way of future growth.

In many of the aviation industry's factories has been incorporated a feature which we feel certain will be utilized more generally by industry after the war.

It is the underground system of entrance and exit, to and from the main manufacturing building. By means of "subways" or basement corridors, a workman enters the plant. After stopping at his locker in an underground room, he proceeds to the stairway nearest his machine or working station. His course is much the same as that of a spectator at a football game, who emerges into the stadium at a point near his seat.

In most of the great, new aviation plants designed by our organization, many thousands of men will be entering and leaving the buildings when shifts

sion. As a matter of fact, they will be automatically expanded as the plant grows.

While we are open minded on the point, our organization favors daylight plant design over the windowless construction. There are unquestionably some advantages in the windowless plant. They are quicker and perhaps simpler to construct: both heat and humidity may be more uniform and more easily controlled. They do require artificial lighting at all times, though, as well as mechanical ventilation and air-cooling.

(*Turn to page* 248)

# "AN-J-C-48

## Army-Navy Aeronautical Specification Cable"

### ...by Auto-Lite Sterling

The joint Army-Navy specifications for "Cable, Electric, Low-Tension, Aircraft" were established to conserve critical materials and produce cable worthy of the world's finest aircraft.

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Employing a special type of cotton and synthetic fibre, with a special braid, the new cable possesses exceptional resistance to wear and physical damage. In addition, the weight of this cable has been reduced considerably over previous types of construction.

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*Johnston & Johnston, Pittsburgh.*

***Segregation of scrap must begin at the machines. These baskets are carefully labeled with the identifying number of the alloy which they hold. Separation of mixed aluminum alloys is extremely difficult, if not impossible, and contamination of one alloy with another prevents reclamation of any. Stainless steel is a typical enemy which cannot be allowed to sneak into aluminum scrap.***

# Conserving Aluminum Scrap

**With industry cooperation, 15 to 20 percent of sheet requirements this year can be met through reprocessing segregated scrap. Aluminum conservation should actually begin in pre-production stages—design and buy wisely.**

**By JOHN ST. PETER,** *Aluminum Co. of America*

SPILL A SPOONFUL of salt into your sugar bowl. Your eye can't tell the difference, but the mixture won't sweeten coffee or flavor soup any more, and there isn't much that can be done to reclaim it.

That's the way with aluminum scrap, too. Once it is contaminated with other metals, it can't profitably be reprocessed into specific commercial alloys. On the other hand, if it is properly handled for re-processing, scrap can play an important part in America's Victory Drive.

If the scrap generated in American fabricating plants this year is carefully segregated and kept free of contamination, enough re-usable metal could be produced to equal the output of a fair-sized aluminum reduction plant. And it goes without saying that every pound of aluminum salvaged frees another pound of primary metal for some other essential purpose in the war effort.

Aluminum production in this country now is several times what it was in the last full peacetime year, 1938, but the present vast expansion program in the industry will not allow any relaxation of the production rate because demand is also swelling to astronomical proportion.

What can we do to convert our growing scrap piles into useful metal? Segregation is the important secret, for contamination—as we have noted—is the "fifth columnist" which does the irremediable damage.

Worst offender in the fifth column of contamination is stainless steel. Dressed in the same raiment as aluminum, it elbows its way in unseen, and boosts the iron content of a batch of scrap to a point that may render it useless for reprocessessing into anything but second-grade material.

Segregation of aluminum scrap from contamination by other metals, however, is not enough. One aluminum alloy must also be kept completely separate from all other aluminum alloys. The characteristics of aluminum alloys depend on the addition of small percentages of alloying elements to the basic metal, and these elements differ in both character and amount with the various alloys.

Alloy 24S, for example, contains 4.5 percent copper, 1.5 percent magnesum, and 0.6 percent manganese; alloy 52S, however, contains 2.5 percent magnesium and 0.25 percent chromium. If batches of scrap from both of these are mixed together, the characteristics of the alloys are lost and the chromium content of the 52S goes to waste. Chromium, of course, is scarce and comes to no small item when the quantities of aluminum scrap being produced today are considered.

It will pay dividends to work out a system of supervision and checks on scrap-handling in your plant. Here are some suggestions for making scrap-handling as fool-proof as possible:

*1.* Begin the segregation of scrap right at the machine that makes it.

*2.* When work on a machine is changed and another alloy is to be used, make certain that the scrap box is changed also, and the machine cleaned before starting the new job.

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The cylinder is held securely in an ingenious work-table which turns and rotates for wet grinding both exhaust and intake valve seats without removing cylinder. ***Wide Range*** — from 4" to $6\frac{7}{16}$" skirt diameter.

The coolant is fed from the bottom upward between cutting wheel and valve seat, thus flushing away all grindings and avoiding scratching of the seat or wheel loading. Coolant pump motor has independent button switch and safety light.

***Time-saving convenience*** everything within easy reach Handy shelf with metal pins to hold grinding wheels, etc Adjustable shaded light arm.

***Power-driven Dressing Tool,*** with separate switch control, using same wheel holder as for grinding

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# Sioux

## AIRCRAFT WET VALVE SEAT GRINDING MACHINE

STANDARD THE WORLD OVER

ALBERTSON & CO., INC. SIOUX CITY, IOWA, U. S. A.

3. Work out a system of identifying the different alloys so that they can be recognized at a glance. Containers of various colors (or colored cards attached to the containers) with matching colored job tickets, using a different hue for each alloy, is a good method. Bricquets of pressed scrap can also be marked in this way.

For many small fabricating companies, including some aircraft manufacturers, it is perhaps not necessary to take such elaborate steps to salvage aluminum scrap. But they, too, can help sustain the supply of aluminum by careful handling and preparation of scrap for re-processing.

In normal times, the advisability of salvaging scrap frequently depends on demand for it in the open market. Today we are not concerned with what is normal; we are concerned with "all out" production, and under this scheme of things scrap conservation by everyone is not only advisable—it is essential.

With reasonably good cooperation on the part of everyone concerned, it is believed that the amount of segregated scrap that can be made available for re-processing this year would amount to 15 percent or 20 percent of the sheet fabricated.

Bottlenecks in aluminum production capacity will be alleviated and a long step taken in the way of conservation if users of aluminum sheet show good judgment in buying. Careful study should be made to determine whether or not proper standard sheet sizes are being specified in your plant. On the other hand, specifications that are too rigid sometimes place an unnecessary burden on the producer, and this may result in increased raw material costs.

Rolling mills can obtain their maximum capacity only by making large production runs without changing alloy or gauge. Sheet is then sheared to standard size. When large sheet in certain sizes is specified, a considerable quantity of smaller sheet is often produced which, unless it can be sold, must be thrown into the scrap pile. Many times, however, fabricators accustomed to ordering only large sheet could just as well use a considerable percentage of smaller sheet. A little ingenuity or a slight slackening of size specifications will frequently permit these small sheets to be used without the necessity of re-processing them. Producers may offer a price advantage if the customer will take 80 percent of an order in specified sizes and 20 percent in "random standard" size.

Production bottlenecks may be further relieved in some cases, and raw material costs likewise reduced, by the use of a larger number of alloys. The demands for 24S alloys, for example, have increased tremendously. Yet some people purchase it purely from habit. Cases have been found where 24S was being specified when lower priced, more easily worked alloys (such as 3S, 53S, and 61S) would have done as good a job—perhaps better. Again, alloy 51S can sometimes be substituted to advantage for the more popular 14S and 17S alloys. Increased use of these and other alloys, many of which can be produced more quickly and economically than 24S, will conserve time and production capacity while reducing fabricators' costs.

Johnston & Johnston, Pittsburgh.

***Where the work done at a particular bench involves frequent changes from one alloy to another, it is convenient to have more than one scrap box close at hand. Before any shift to a different alloy, the box used previously is carefully covered and the proper one for each new kind of scrap propped open. The number of the alloy is marked in bright colors on each lid, corresponding to the number on the box beneath.***

## Tools Are "Weapons"

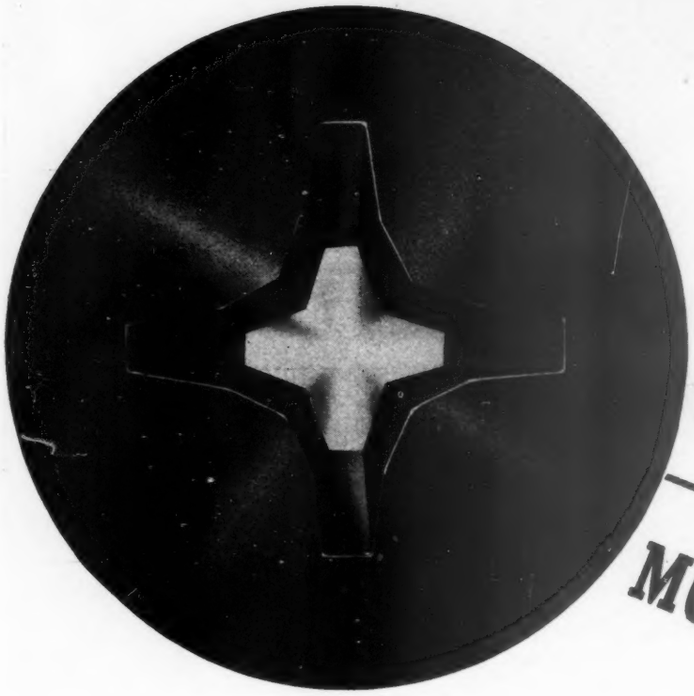
### To Be Conserved and Used Wisely

Under the heading of "Conservation Control Plan," Henry Disston & Sons, Inc., has devised a helpful system of conserving tools so that they may give a maximum life. The plan applies, naturally, to the types of saws, cutters, files, knives and the like which the company manufactures, but is applicable to all types of tools if the users care to provide corresponding forms.

To effect conservation of tools, which is of great importance when, as at present, the supply is not up to the demand, the plan aims to instruct the worker in the proper choice, correct use and right care of the tools dealt with. To this end, there is supplied, free of charge, for each of 35 types of tools, a "Conservation Control Card" which gives brief but explicit instructions on the nature of failures, their cause and how they can be corrected or avoided. Where different types of material are to be worked, the card shows, in the case of hack saw blades, for example, the number of teeth per inch, the number of strokes per minute and the pressure which should be applied for best results.

Cards may be issued with the tools, when they are drawn from the tool room, posted at the machine or bench where the tool is used, or distributed in any way that the management thinks the card will best serve its purpose. It is contended that the cards serve the interest of all parties concerned, including the workman, whose job is made easier and whose work is speeded by following the recommendations given on the card.

Thirty-five different cards, each for a different type of tool are now in print. Each one is reproduced in a booklet available from Disston without charge. The booklet also contains an order form for the cards and any number of each can be secured, also without cost, by manufacturers who employ the types of tools referred to. Shops which use the cards are reported to have found them exceedingly helpful in promoting tool conservation.



# MULTIPLYING A MONEY-SAVING PLUS

## By 3

***America's leading firms write "American Plus" in front of "Phillips" on their orders . . . to get "3 Plusses" with every recessed head screw***

**American's Engineering.** The engineers who first helped to develop the patented Phillips Recess have naturally led the way in helping screw-using industries save millions of dollars . . . by applying this great advance in screw design to countless assembly lines. American Screw Company engineers are available to help *you* affect similar time-and-motion savings . . . savings which cut unit-assembly costs an average of 50%.

**American's Quality Control.** Both raw materials and methods of manufacture pass under constant scrutiny in American Screw Company's chemical and metallurgical laboratories. Testing machines . . . for metal structure, torque, vibration, shear, etc. . . . insure the complete reliability of every shipment of American PLUS Phillips Screws.

**American's Inspection Methods.** There are few, if any, parallels in the screw industry for American Screw Company's unique system of piece inspection which watches every single screw for defects . . . and permits no single package to leave the plant without its full complement of screws.

**Multiplying distributors to meet multiplied demand.** The "3 Plusses" are 3 good reasons why America's leading manufacturers have multiplied their demand for American PLUS Phillips Screws . . . and also why more and more mill supply distributors are prepared to meet their increased demands — and *yours* — right now!

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# AMERICAN PRODUCED THE PLUS ...
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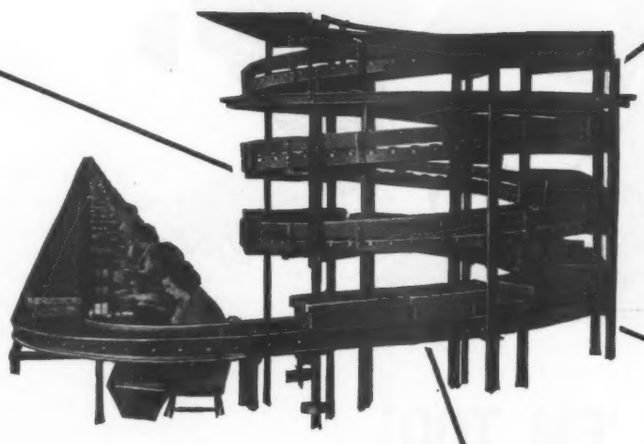
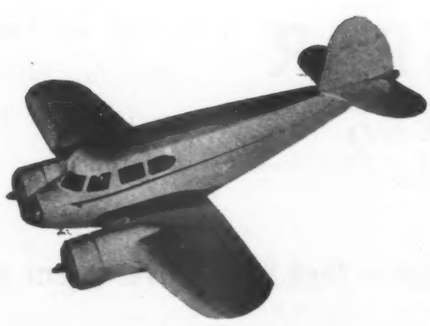
Vultee... another famous name in aircraft, served by American Screw Co.



Brewster uses
American PLUS Phillips Screws



In the Cessna Plant, you'll find planes being assembled the high-speed way —with American PLUS Phillips Screws.

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Problem pilots were as tough on the structural parts of the planes they flew as the heat, cold, sun, rain and ice were destructive to the finishes of those days. Finding a practical, durable, protective finish was a problem—back in 1918!

Valspar helped solve that problem just as it is helping to solve today's finishing problems. Plane manufacturers winning the battle of production schedules are using more and more Valspar Val-Aero Aircraft Finishes every day.

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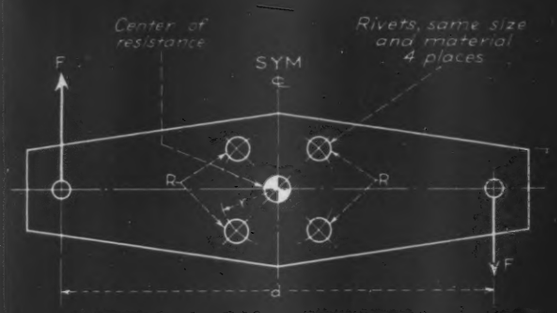


Fig. 1. Diagram of a couple being resisted by a group of rivets equally spaced about the center.

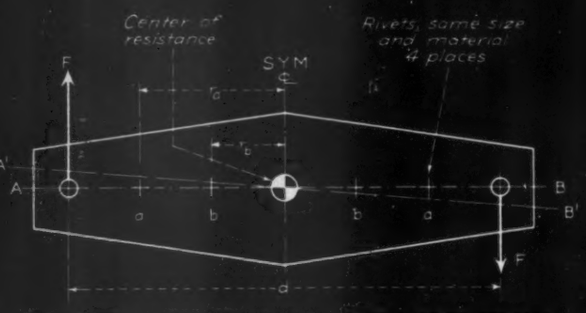


Fig. 2. Rivet load for case of a couple being resisted by a number of rivets equally spaced about a point.

# STRENGTH ANALYSIS of Riveted and Bolted Joints

**The concluding part of an article on how the strength of riveted and bolted joints is calculated by the structural engineer.**

**By WAYNE A. McGOWAN,** *Senior Stress Analyst, Consolidated Aircraft Corp.*

TO HAVE ALL the rivets of a joint carry an equal load (provided they are of the same size and material) it is essential that the line of action of the resultant of the loading pass through the center of resistance of the rivet group. The location of the center of resistance of a rivet group is determined as explained in the previous article in the April, 1942 issue of AVIATION. If the resultant loading does not pass this point, the rivets are not equally stressed. The calculation of the load on any rivet due to a torsional effect, is based on the assumption that the rivet is stressed in direct proportion to the distance of the rivet from the center of resistance of the rivet group.

The load on a rivet due to torsion is first determined for the elementary case of a couple being resisted by a group of rivets equally spaced about the center of the group. (See Fig. 1.) All of the rivets are of the same size and made from the same material.

Applied moment $= Fd$

Resisting moment $= 4Rr$

For a condition of equilibrium

$$Fd = 4Rr \text{ or } R = \frac{Fd}{4r}$$

In this explanation $(R)$ represents the reaction of the rivet on the plate and not the reaction of the plate on the rivet as in most of the following examples. Since these two forces are of equal magnitude, although oppositely directed, it is immaterial from a strength analysis viewpoint in which way the reaction is considered to act. The load $(R)$ on each rivet always acts in a direction which is at right angles to the radius from the center of resistance to the rivet in question.

The rivet load for the simple case of a couple being resisted by a number of rivets equally spaced about a point is generalized for the condition where the rivets are not all spaced at the same distance from the center of resistance of the group. If the rivets of the group are all of the same size and material, it can be shown that the load on any rivet is proportional to its distance from the centroid. (See Fig. 2.)

$T_a = (F)(dFd)$

(Applied Torsional Moment)

The moment on the rivet group will stress the rivets and there will be a corresponding strain on each. Assume that the strain of the rivets along the line AB allows the plate to rotate so that AB become A′B′. The rivets are assumed not to be strained beyond the proportional limit and as a result the the line AB originally straight remains straight. By similar triangles the strain at rivet (a) and at rivet (b) is proportional to their radial distances from the center of resistance or,

$$\frac{\text{Strain (a)}}{\text{Strain (b)}} = \frac{r_a}{r_b}$$

Since stress is proportional to strain, if the proportional limit of the material is not exceeded, the stress at rivet (a) and at rivet (b) are also proportional to their radial distances from the center of resistance.

$$\frac{\text{Stress (a)}}{\text{Stress (b)}} = \frac{r_a}{r_b}$$

For the same area of rivet, the rivet load will be proportional to the radius or,

$$\frac{\text{Rivet load (a)}}{\text{Rivet load (b)}} = \frac{r_a}{r_b}$$

Let $P$ be the load on the rivet at unit radius, $(r_1)$ from the center of resistance. The load at any other rivet is load $= Pr$ where $r$ is the distance from the center of resistance to the rivet. For rivet $(a)$, load $= Pr_a$. For rivet $(b)$, load $= Pr_b$.

Taking moments of the unit loads about the center of resistance and noting that there are two rivets at (a) and two at (b)

$$M = 2\,[(load\ a)\,(r_a) + (load\ b)\,(r_b)]$$
$$M = 2\,[(Pr_a)\,(r_a) + (Pr_b)\,(r_b)]$$
$$M = 2\,(Pr^2_a + (Pr^2_b)$$
$$= 2\,P(r^2_a + r^2_b)$$

The load on the rivet at unit radius is:

$$P = \frac{M}{2\,(r^2_a + r^2_b)}$$

The load on the rivet (a) is the maximum load and is:

Photo courtesy Curtiss-Wright Corporation.
Model is the Curtis P-40

# Ohio Seamless Tubing ARMORS THE OIL



*Above:* The Final Assembly Department of the Curtiss-Wright Corporation where engine controls are hooked up to the cockpit and fuel lines to tanks and gauges.

VITALLY important are the hidden arteries that feed oil to motors through fast flights and gruelling combat. Engineers who write specifications figure in the terrific torture those oil lines must take in stride.

Ohio Seamless Tubing is used in many airplane parts. For use in oil lines tubing must be ductile—and at the same time tough enough to weather tremendous vibration and strain. A non-oxidized, bright finish, controlled temperature annealed tubing is used. Military specifications state that materials shall be straight, smooth, clean and free from seams, tears, grooves, laminations, slivers, pits, and other injurious defects.

For the manufacture of war plane parts—as for peacetime industry—Ohio Seamless Tubing is furnished in many types and grades of steel and alloys, in a wide variety of gauges, lengths and finishes.

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OHIO SPECIAL QUALITY

$$P_a = \frac{Mr_a}{2\,(r^2_a + r^2_b)}$$

The expression 2 $(r^2_a + r^2_b)$ represents the sum of the squares of the distance of the rivets from the center of resistance of the group. This term is often referred to as the "inertia" of the rivet group. This phraseology is not correct however, since the inertia of an area is given by the expression:

$$\Sigma\,(A_1 y_1^2 + A_2 y_2^2, \text{ etc.})$$

where $y$, $y_2$, etc. are the distances from the center of resistance of the total area to the centroids of each of the component areas making up that total. The location of the center of resistance and the determination of the moment of inertia of rivet groups is explained below.

## CENTER OF RESISTANCE

The location of the center of resistance of a number of rivets comprising a rivet group is required for the determination of the maximum load applied to any one of the rivets. If the resultant load on the rivet group passes through the center of resistance, it is customary to assume that all rivets are equally stressed. If the resultant load does not pass through the center of resistance, the stress on all of the rivets is not the same, and the load on any rivet must be determined as explained in Part I.

If all of the rivets in any group are of the same material, the center of resistance coincides with the centroid of the total cross-sectional area of the rivets. Such a centroid can be found by the same method as for finding the centroid of any area which is made up of a number of elementary parts. However, if all rivets of the group are of the same diameter, and consequently the same area, it is more convenient to represent the area of each rivet as a unit. In a similar manner the total area of the rivet group is represented by the total number of unit areas comprising the group. The centroid is then found in the same manner as though the actual cross-sectional areas of the rivets were being used. (See Fig. 3.)

$$A = 3 + 2 + 1 = 6$$
$$6x = (3 \times 0) + (2 \times .75) + (1 \times 1.5)$$
$$6x = 0 + 1.5 + 1.5 = 3$$
$$x = .5$$

This method of solution eliminates the necessity of computing the actual areas of the rivets and performing computations involving decimal fractions. As a result, greater accuracy is obtained, and less time and effort are required.

In many cases two or more different sizes of rivets are used in the same rivet group. The center of resistance or centroid of such groups can be determined by the same method as previously described if the areas of each of the

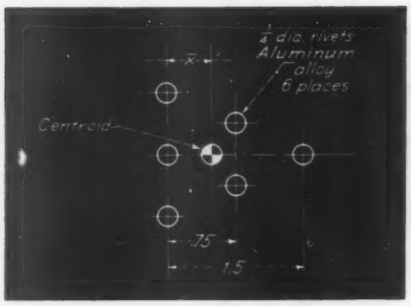


*Fig. 3. Finding the centroid.*

rivets are represented in terms of the area of one size of rivet making up the group. For example, in a group of rivets including both $\frac{3}{16}$ and $\frac{1}{4}$ rivets, the area of each $\frac{1}{4}$ rivet can be represented in terms of the area of one $\frac{3}{16}$ rivet.

Since the cross-sectional area of the round shank of the rivet is proportional to the square of its diameter, the area of each $\frac{1}{4}$ rivet is represented as follows:

$$\frac{\text{Area } \frac{1}{4} \text{ rivet}}{\text{Area } \frac{3}{16} \text{ rivet}} = \frac{(4/16)^2}{(3/16)^2} =$$

$\frac{16}{9}$ times the area of one $\frac{3}{16}$ rivet.

Or, if the $\frac{1}{4}$ rivet is used as a basis of comparison.

$$\frac{\text{Area } \frac{3}{16} \text{ rivet}}{\text{Area } \frac{1}{4} \text{ rivet}} =$$

$\frac{9}{16}$ times the area of one $\frac{1}{4}$ rivet.

(See Fig. 4.)

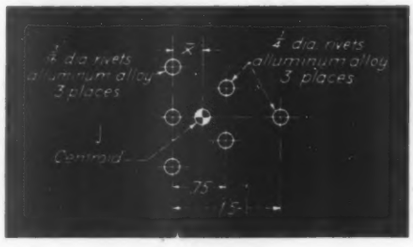


*Fig. 4. Finding the areas of rivets.*

$$\tfrac{1}{4} \text{ Alum. Alloy rivet equivalent to } \left(\frac{16}{9}\right)$$
$$\tfrac{3}{16} \text{ Alum. Alloy rivet}$$

$$\text{Equivalent A} = (3 \times 1) + \left(2 \times \frac{16}{9}\right) + \left(1 \times \frac{16}{9}\right)$$
$$= 3 + 3.56 + 1.78 = 8.34 - \tfrac{3}{16} \text{ Alum. Alloy Rivets}$$

$$8.34\,x = (3 \times 1 \times 0) + 2 \times \frac{16}{9} \times .75) +$$
$$(1 \times \frac{16}{9} \times 1.5) = 0 + 2.67 + 2.67 = 5.34$$
$$x = .64$$

If the rivets comprising the group are not all made of the same material, as for instance, in a joint using both steel and aluminum alloy rivets, the center of resistance of the group is not at the centroid of the area of the rivets. Instead, the center of resistance coincides with a point which would be the centroid of the total area if all rivets were expressed as areas which have been modified so as to take account of the difference in moduli of elasticity of the metals used for the rivets in the joint. It is shown in a later section that in a joint using both steel and aluminum alloy rivets, the ratio of the load (or resistance from) a steel rivet to that of an aluminum alloy is the same as the ratio of their moduli of elasticity in shear (also called moduli of rigidity). The modulus of elasticity in shear for steel is 11,000,000 lb. per sq.in., and for either aluminum or any of the aluminum alloys is 3,800,000 lb. per sq.in.

$$\frac{E_s \text{ (Steel)}}{E_s \text{ (Alum. Alloy)}} = \frac{11{,}000{,}000}{3{,}800{,}000} = 2.8$$

Since the ratio of these two values is the same as the ratio of the ordinary tension moduli of elasticity of the two materials and the latter values are more easily obtained and remembered, the tension moduli of the metals, rather than the shear moduli (modulus of rigidity) are used.

$$\frac{E_t \text{ (Steel)}}{E_t \text{ (Alum. Alloy)}} = \frac{29{,}000{,}000}{10{,}300{,}000} = 2.8$$

Thus, for a joint which consists of rivets, all of the same size but some made from steel and some made from aluminum alloy, the center resistance of the group coincides with the centroid of an equivalent, total cross sectional area in which the area represented by each steel rivet is replaced by an equivalent area of aluminum alloy which is 2.8 times as large as the actual area of the steel rivet. In other words, each steel rivet is assumed to be replaced by 2.8 aluminum alloy rivets of the same size. (See Fig. 5.)

$\frac{1}{4}$ Dia. Steel Rivet equivalent to (2.8) $\frac{1}{4}$ Alum. Alloy rivets

Equivalent A = 3 + 2 (2.8) + 1 (2.8) = 3 + 5.6 + 2.8 = (11.4) $\frac{1}{4}$ Alum. Alloy Rivets

$$11.4x = (3 \times 0) + (2 \times 2.8 \times .75) + (1 \times 2.8 \times 1.5) = 0 + 4.2 + 4.2 = 8.4$$
$$x = .736$$

If both the size of the rivets and the material from which they are made are

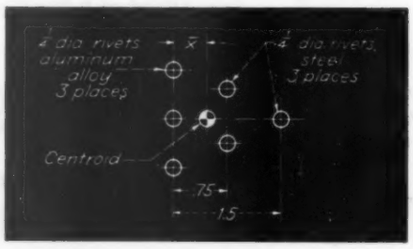


*Fig. 5. Riveted joint consisting of steel and aluminum alloy rivets of the same size.*

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not the same throughout the joint, the combined effect of both of these variables must be considered. This can be accomplished by an application of the principles outlined above.

It was assumed in the previous examples that all of the rivets in the group were critical in shear, and the center of resistance was therefore at the centroid of the area in all cases where the rivets were all made from the same material. In some instances, however, the thickness of the plates is insufficient to develop the full shear strength of some of the rivets in the joint. This does not affect the location of the center of resistance of the rivet group if all of the rivets are of the same size and made from the same material, even though the total strength of the joint is reduced. However, if some of the rivets are critical in shear, and the remaining rivets critical in bearing, the center of resistance must be located by making due allowance for the rivets which are critical in bearing. This is accomplished by using an "effective area" for each of the rivets which are critical in bearing.

The "effective area" for any such rivet is equal to its actual area multiplied by the ratio of its bearing strength to its shear strength. Thus, if a joint consists of $\frac{1}{8}$ and $\frac{5}{32}$ rivets attaching two plates of .040 Alclad 24ST to form a lap joint is being considered, the center of resistance is computed on the basis of one $\frac{5}{32}$ rivet being equivalent to $\frac{615}{745} = .825$ of one $\frac{5}{32}$ rivet.

This is true because the bearing strength of $\frac{5}{32}$ rivets in .040 Alclad 24ST is only 615 lb., while its shear strength is 745 lb. The shear strength of the $\frac{1}{8}$ rivets is 331 lb. and the bearing strength in .040 Alclad 24ST is 410 lb. Consequently, the $\frac{1}{8}$ rivets are critical in shear and their effective area is numerically the same as their actual area.

In a riveted joint consisting of $\frac{1}{4}$ aluminum alloy rivets and AN3 steel bolts ($\frac{5}{32}$ D), both bearing in .072 Alclad 24ST plates, the $\frac{1}{4}$ bearing. As a result, the area of the steel bolts are represented by only $\frac{1107}{2126} = .527 = 52.7$ percent of their actual area, since the bearing strength is only 1107 lb. whereas the strength in shear is 2126 lb.

## MOMENT OF INERTIA

The polar moment of inertia of any area with respect to an axis perpendicular to the plane of the area is stated mathematically by the expression $\int r^2 d_A$, where $(r)$ is the distance from the center of the element area $(d_A)$ to the axis with respect to which the moment

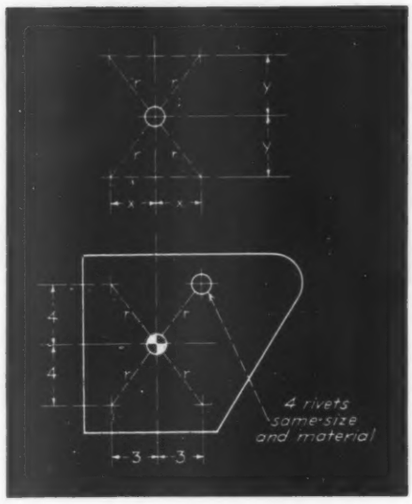


*Fig. 6. Alternate solution, dealing with rivets of the same size and material.*

of inertia has been or is to be determined. If the entire area is made up of a number of component areas, such as in the case of a rivet group, the moment of inertia is more conveniently calculated by the use of the parallel axis theorem. In such cases, the moment of inertia is defined by the expression $I_p = (I_o + Ar)$, where $(I_o)$ is the polar moment of inertia of the cross-sectional area of each rivet with respect to its own centroidal axis (which coincides with the longitudinal axis of the rivet shank), $(A)$ is the cross-sectional area of the rivet, and $(r)$ is the distance from the centroidal axis or center of the rivet to the center of resistance of the rivet group. The moment of inertia of each rivet about its own centroidal axis $(I_o)$ is of negligible importance and is usually neglected. As a result, the expression $I_p = (r^2_a A_a + r^2_b A_b$, etc.) can be used to compute the moment of inertia of the rivet group. This quantity, when substituted in the torsion formula $\frac{Mr}{I}$, gives the torsional shear stress (lb. per sq.in.) on the rivet located at $(r)$ inches from the center of resistance.

A more practical analysis of a rivet group involves a quantity which is similar to the moment of inertia as described above, but instead of dealing with the actual areas of the various rivets, the area of each rivet is represented as a unit or multiple of some unit. This is the same procedure as described previously in the paragraphs entitled, Center of Resistance.

For example, if all of the rivets of the group are made from the same material and the same diameter, the "inertia" of the group can be written ($r^2_a + r^2_b$, etc.) This quantity is not actually the moment of inertia of the rivet group as actual areas are not involved.

The advantage in using this alternate solution is that it eliminates the necessity of computing the actual areas of the rivets and performing computations involving decimal fractions. As a result, greater accuracy is obtained and less time and effort is required. In addition, the "inertia" quantity when substituted in the torsion formula $\frac{Mr}{I}$ gives the torsional shear load (lb.) on the rivet located at $(r)$ inches from the center of resistance. (See Fig. 6.)

Since the location of the rivets is usually specified by two rectangular dimensions, horizontal and vertical, it is convenient to compute the value of $r^2$ by using the dimensions on the drawing. The dimension $(r)$ corresponds to the length of the hypotenuse of a right triangle which has two legs $(x)$ and $(y)$ inches long. By the Pythagorean theorem:

$$r^2 = x^2 - y^2$$

$$\text{Therefore, } \Sigma r^2 = \Sigma x^2 + \Sigma y^2$$

Using the previous example as a reference:

$$\Sigma r^2 = \Sigma x^2 + \Sigma y^2 = 4(3^2) + 4(4^2) = 4(9) + 4(16) = 36 \times 64 = 100$$

If all rivets in the group are not of the same diameter, and consequently the same area, the inertia of the group can be determined by the same method as previously described, provided that the area of each of the rivets is represented in terms of the area of one size of rivet making up the group. For example, in a group of rivets including both $\frac{5}{32}$ and $\frac{1}{4}$ rivets, the area of each $\frac{1}{4}$ rivet is represented in terms of the area of one $\frac{5}{32}$ rivet, the equivalence factor being the ratio of their areas, or 16/9 as shown under Center of Resistance.

If the rivets comprising the group are not all made of the same material as, for instance, a joint using both steel and aluminum alloy rivets, the area represented by each steel rivet is replaced by an equivalent area of aluminum alloy which is 2.8 times as large as the actual area of the steel rivet. In other words, each steel rivet is assumed to be replaced by 2.8 aluminum alloy rivets of the same size.

If both the size of the rivets and the materials from which they are made are not the same throughout the joint, the combined effect of both of these variables must be considered. This can be accomplished by an application of the principles outlined above.

It was assumed in the previous example that all of the rivets in the group were critical in shear, and the moment of inertia was therefore calculated on the basis of the cross-sectional areas of the rivets. In some instances, however, the thickness of the plates are insufficient to develop the full shear strength of some of the rivets in the joint, and

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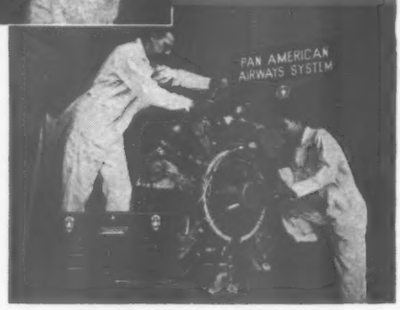


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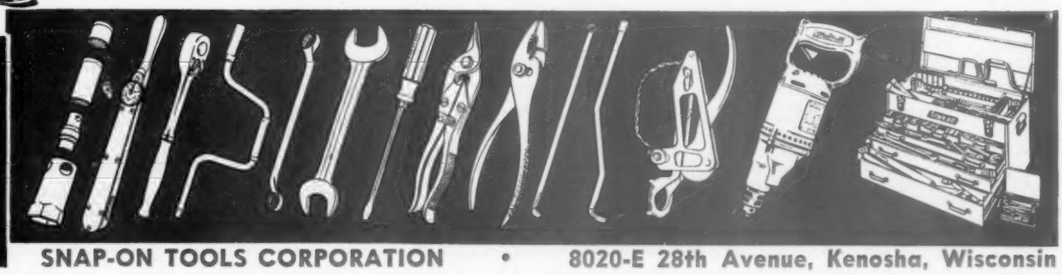

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consequently the inertia of the rivet group should be reduced. This is accomplished by using an "effective area" for each of the rivets which is critical in bearing. The effective area for any such rivet is equal to its actual area multiplied by the ratio of its bearing strength to its shear strength.

The parallel axis theorem, as stated previously, is a convenient tool to use when calculating the moment of inertia of rivet groups. Using this formula it is possible to determine the inertia of the group by employing the same dimensions used in calculating the position of the center of resistance. In this way the process of computing the distance from the center of resistance to each of the rivets is eliminated. The resulting saving in time and effort is apparent by an examination of the following example which is solved in two ways. (See Fig. 7.)

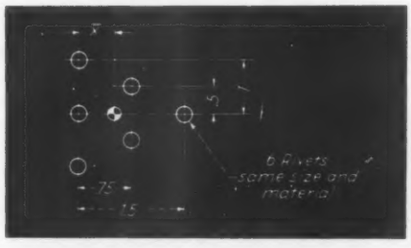



*Fig. 7. Parallel axis theorem for calculating moment of inertia of rivet groups.*

$$A = 3 + 2 + 1 = 6$$
$$6x = 3\,(0) + 2\,(.75) + 1\,(1.5)$$
$$6x = 0 + 1.5 + 1.5 = 3$$
$$x = 0.50$$
$$x^2 = 0.25$$

$\Sigma x^2$ *by the use* of the parallel axis theorem:

$$\Sigma x^2 = 3\,(0)^2 + 2\,(.75)^2 + 1\,(1.5)^2 - 6\,(x)^2$$
$$= 3\,(0) + 2\,(.5625) + 1\,(2.25) - 6\,(.25)$$
$$= 0 + 1.125 + 2.25 - 1.5 = 1.875$$

$\Sigma x^2$ *without the use* of the parallel axis theorem

$$\Sigma x = 3(.50)^2 + 2(.75 - .50)^2 + 1(1.50 - .50)^2$$
$$= 3(.50)^2 + 2(.25)^2 + 1(1.00)^2$$
$$= 3(.25) + 2(.0625) + 1(1.00) = .75 + .125 + 1.00 = 1.875$$

$$\Sigma y^2 = 2(1)^2 + 2(.5)^2 = 2(1) + 2(.25) = 2.50$$

$$\Sigma r^2 = \Sigma x^2 + \Sigma y^2 = 1.875 + 2.50 = 4.375$$

The great advantage in using the parallel axis theorem is realized in preliminary design, where rivets are added to or subtracted from a joint until a satisfactory joint is derived. By use of the parallel axis relationship, it is possible to determine the new value of the moment of inertia after each change with a minimum of computation. If new distances for each rivet are computed, and computations performed without use of the parallel axis theorem, the labor involved becomes considerable.

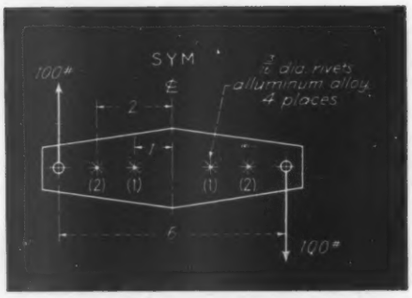



*Fig. 8. Determining rivet load due to action of torsional moment on a rivet group. Rivets all same size and material.*

## TORSIONAL MOMENT

The application of the derived formula for determining the rivet load due to the action of a torsional moment on a rivet group is shown by the following examples. For simplicity, the first example is chosen with all rivets of the same size and material. Exceptions to the case are considered later. (See Fig. 8.)

$$M = 100 \times 6 = 100 \text{ in. lb.}$$
$$I = 2\ (1^2 + 2^2) = 10$$

$$P_1 = \frac{Mr_1}{1} = \frac{600 \times 1}{10} = 60 \text{ lb.}$$

$$P_2 = \frac{Mr_2}{1} = \frac{600 \times 2}{10} = 120 \text{ lb.}$$

In many joints, two or more different sizes of rivets are used in the same rivet group. In these cases the assumption that the load on any rivet is proportional to its distance from the center of resistance is no longer valid. However, if the rivets comprising the group are all made of the same material, the stress on the rivets remain proportional to the distance from the center of resistance. Since the load on the rivet is the product of the stress and the area, the load on the rivet can be determined by a reasonably simple additional calculation. (See Fig. 9.)

$$M = 100 \times 6 = 600 \text{ in. lb.}$$

Area of one ¼ rivet equals $\frac{16}{9}$ times the area of one $\frac{3}{16}$ rivet

$$I = 2\,[1\,(1)^2 + \frac{16}{9}\,(2^2)]$$
$$= 2(1 + 7.11) = 16.22$$

$$P_1 = \frac{Mr_1}{1} = \frac{600 \times 1}{16.22} = 37 \text{ lb.}$$

$$P_2 = \frac{16}{9}\,\frac{Mr_2}{1} = \frac{16}{9}\,\frac{600 \times 2}{16.22} = 131 \text{ lb.}$$

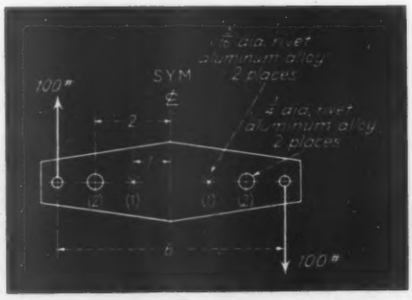



*Fig. 9. Determining load with rivets of two or more sizes, but of the same material.*

If the rivets comprising the group are not all made of the same material, as for instance, in a joint using both steel and aluminum alloy rivets, the assumption that the load on any rivet is proportional to its distance from the center of resistance is no longer valid. Since stress is proportional to strain, if the proportional limit of the material is not exceeded, the stress on any rivet will be dependent upon the shear modulus of elasticity of the rivet material as well as the distance of the rivet from the centroid. This is true because all rivets at a given distance from the center of resistance must be strained an equal amount. To fulfill this requirement, the steel rivets must be more highly stressed than the aluminum alloy rivets, the actual ratio of the stress being the same as the ratio of their shear moduli of elasticity. (See Fig. 10.) This ratio is

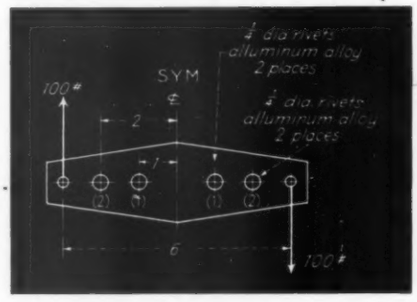



*Fig. 10. Determining load with rivets of different materials.*

2.8 as shown under Center of Resistance of rivet groups.

$$M = 100 \times 6 = 600 \text{ in. lb.}$$

Area of one ¼ steel equivalent to 2.8 times the area of one ¼ Aluminum Alloy rivet.

$$I = 2\,[1(1)^2 + 2.8\,(2)^2] = 2\,(1 + 11.2) = 24.4$$

$$P_1 = \frac{Mr_1}{I} = \frac{600 \times 1}{24.4} = 24.9 \text{ lb.}$$

$$P_2 = (2.8)\,\frac{Mr_1}{I} = (2.8)\,\frac{600 \times 2}{24.4} = 138 \text{ lb.}$$

## RIVET GROUPS UNDER DIRECT LOAD AND TORSIONAL MOMENT

The previously described methods of analysis are applicable to rivet groups which are either centrally loaded so that the resultant of the applied load acts through the center of resistance of

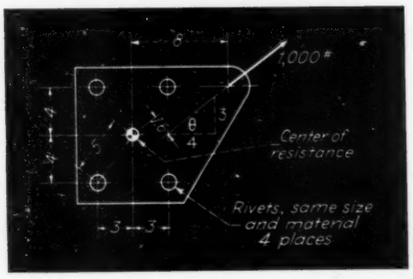



*Fig. 11. Combination of graphical and analytical methods in determining resultant loads on any rivet.*

the rivet group, or loaded by a couple so that the rivet group is subjected to a torsional moment only, unaccompanied by any load tending to cause translation. Such cases as these do occur separately, but more often the resultant of the applied loads does not pass through the center of resistance of the rivet group, and as a consequence, the joint is subjected to a combination of a central load and a couple. It should be noted that any load which is not a central load can always be replaced by a central load of equal magnitude together with a couple whose magnitude is equal to the product of the force and the perpendicular distance from the line of action of the force to the center of resistance of the rivet group.

To find a load on any rivet in a rivet group which is subjected to both a direct load and a torsional moment, the load on the rivet due to each of these loadings is computed and from these the resultant load on the rivet is determined.

In determining the resultant load on any rivet, it is possible to use either graphical or mathematical (analytical) methods of solution. Both methods will be explained inasmuch as neither can be said to be the more practical. In many cases a combination of the two methods will prove useful. (See Figs. 11, 12, 13, 14, 15, 16.)

$$\text{Applied Moment} = 1000 \times 1.6 = -1600 \text{ in. lb.}$$
$$\Sigma r^2 = 4(5^2) = 4 \times 25 = 100$$

These two components of the resultant rivet load are combined vectorially to obtain the maximum resultant rivet load. In most cases the most highly loaded rivet can be selected by inspection, and the resultant load on only this rivet is determined. However, it is advisable to compute the resultant load on all rivets (Fig. 12) in the group which might possibly be critical to insure that the maximum load on any rivet is determined.

It should not be assumed that all of the diagrams shown are actually required to solve the given problem. For explanation each separate operation is illustrated, but in a practical solution all operations are included on a single diagram.

For convenience, the applied load of 1,000 lb. may be resolved into its vertical and horizontal components and applied at the center of resistance of the rivet group. The couple tending to cause rotation about the center of resistance, is computed by using these components of the applied load rather than the force itself. For this computation the two components can be assumed to act at any point along the line of action of the force.

For simplicity, the point at which the

(*Turn to page 260*)

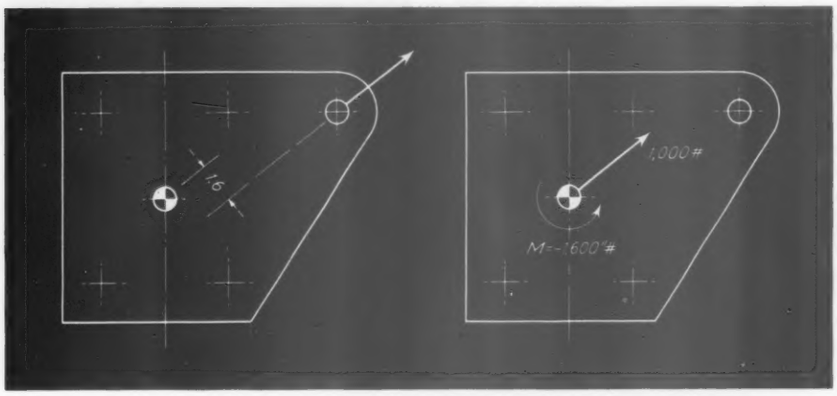



*Fig. 12. Graphical solution in determining resultant loads; left, given loading, right, equivalent loading.*

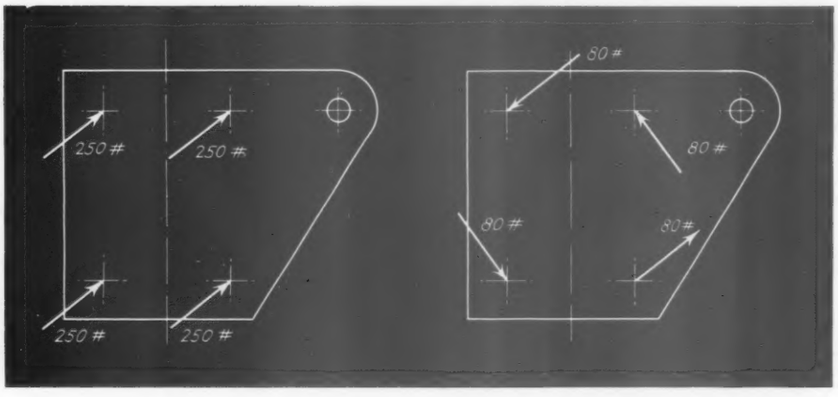



*Fig. 13. Rivet load from central load, left, and rivet load from moment—graphical solution.*

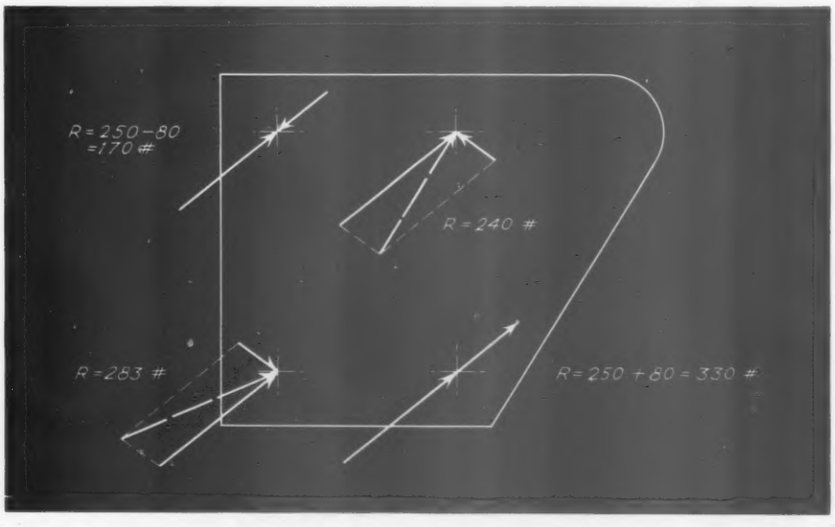
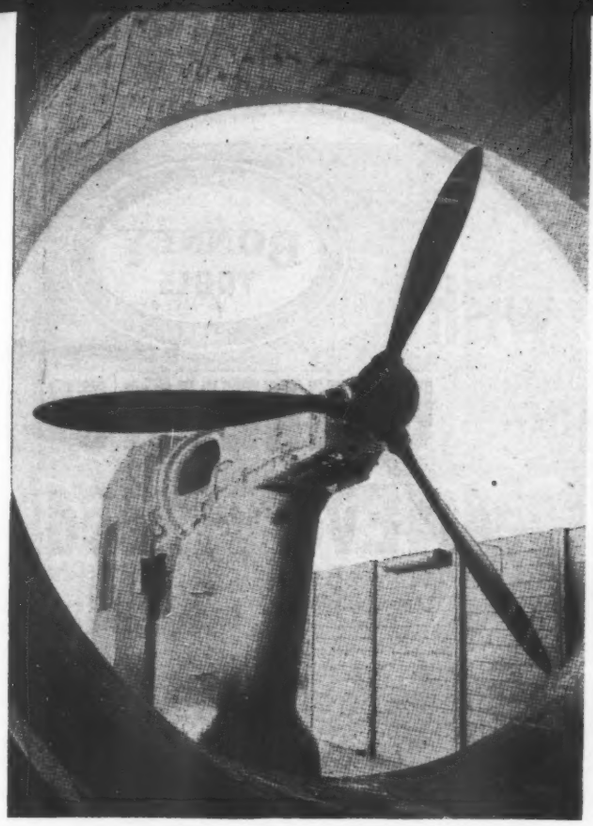



*Fig. 14. Resultant loads on rivets.*



# DYNAMIC BALANCING Of Propellers

By E. KRONAUER

*Escher Wyss Engineering Works, Ltd. Zurich, Switzerland*

**A dynamic balancing device for special investigations on finished, ready for service propellers.**

THOUGH ACCURATE STATIC balancing is quite adequate for practical requirements, a dynamic balancing plant of perfect aerodynamic design has been constructed by Escher Wyss for special investigation work on propellers. The undisturbed onflow thereby obtained, combined with direct observation of the entire course of oscillation and the phases—instead of the method hitherto in use of determining mean value — provides refined means enabling dynamic unbalance to be reliably ascertained. The balancing plants hitherto in use embody certain sources of error in their construction, a fact which has been proved by means of comparative tests carried out with the new plant, in which a free outflow of air, as also an artificially impeded flow, were employed.

Whereas mechanical unbalance in propellers is caused by slight differences in weight, axial position and the paths of the centers of gravity of the blades, aerodynamic unbalance is a result of inequalities in the air pressure. It may be of the same magnitude as the mechanical unbalance, and is caused:

1. By the propeller itself, by slight differences in pitch and shape of blades, etc. It is only by dynamic balancing in a vacuum chamber that this kind of unbalance is distinguishable from the mechanical. It is, however, unnecessary to go so far, for smooth running requires that unbalance be eliminated altogether, no matter whether it originates from air or centrifugal forces. This aerodynamic unbalance of the first kind, together with the mechanical, produces in terms of time a sine-formed oscillation as depicted in Fig. 1.

2. By the surroundings. If there are obstacles to impede the airflow, not only will eddies be formed which are independent of the number of revolutions, but in addition, every time a propeller blade passes such an obstacle the impounded air imparts a thrust to the blade, producing for a propeller with n-blades an n-fold harmonic oscillation, as depicted in Fig. 2. In reality the sum of the two oscillations yields the resultant shown in Figs. 3 and 4. This is the picture which appears on the 17x20 cm. frosted-glass screen of the optical oscillation indicator (Fig. 5). The source of illumination Q sends a beam of light L through a system of lenses S and and an aperture B on to the two small mirrors M which split the beam into two parts to which oscillations are imparted by the two sprung bearings A influencing the two mirrors. By means of a turning polygon-shaped mirror P driven by the propeller shaft the oscillating beams of light are horizontally separated in function of the time and projected on to a frosted-glass screen. Each abscissa shown on the latter (e.g. position of the maximum a

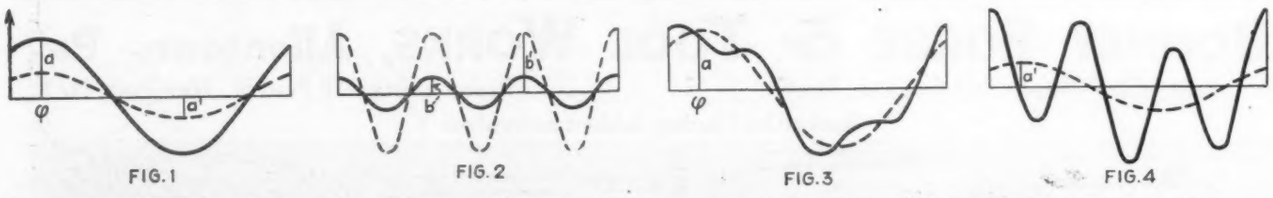



FIG. 1 FIG. 2 FIG. 3 FIG. 4

*Fig. 1. A sine-formed oscillation. The unbalance oscillation is the easier to measure the less the friction, which would reduce the reaction of the measuring instrument to the amount indicated by broken-line curve . . . Fig. 2. If measurements are to be capable of full evaluation, airflow shocks must be small. Each time a propeller blade passes an obstable, the impounded air imparts thrust to the blade producing an n-fold harmonic oscillation as shown . . . Fig. 3. The sum of the two oscillations, showing perfect measurement due to aerodynamically favorable design and minimum friction . . . Fig. 4. With unfavorable design the oscillation spoils measurement result.*

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The long type is made with twenty different combinations of openings ranging from 3/8" to 1 7/16" and varying in length from 7 5/8" to 18" depending upon the size of the opening.

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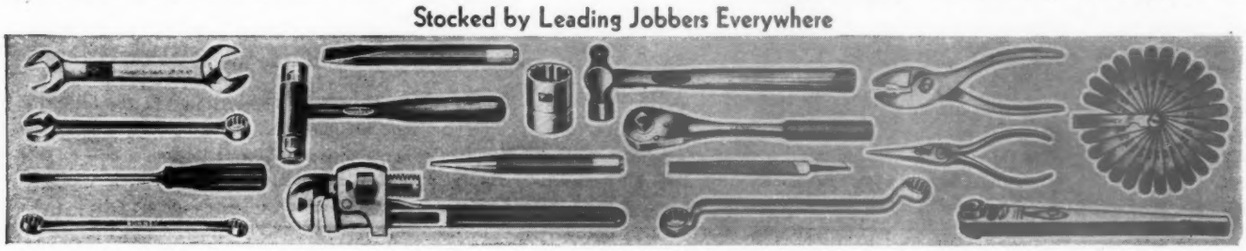

for an angle of rotation $\varphi$ in Fig. 3) corresponds to a definite angle setting of the graduated disc N of shaft W and thus of the propeller itself. It is evident that particularly the moving parts of this measuring device were constructed with the utmost precision.

It is not difficult to read off on the frosted-glass screen the desired sine-line (the broken line in Fig. 3) as well as the position $\varphi$ ( = abscissa) and amplitude **a** of the highest point—provided the disturbance amplitude **b** is small.

When the usual type of testing plant for steam turbine rotors (Fig. 2) is employed for propellers, the airflow is greatly impeded, thus producing a high disturbance amplitude **b**. The new design, however, embodies a long, projecting nose similar to the bow and engine-cowl of an aircraft; the propeller is not mounted between two bearings but is overhung on one side. It is thus possible greatly to reduce the disturbance amplitude **b** (Fig. 2).

The combined oscillation in Fig. 3 is of the following form:

$$x = a \sin (\omega t - \phi) + b \sin 3\,\omega t.$$

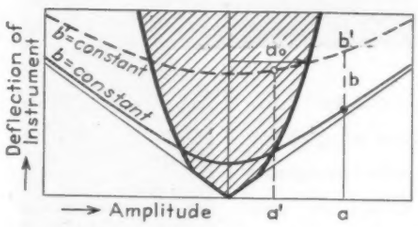


*Fig. 6. With mean-value measurements hitherto customary, limit of insensitivity (shaded) in which instruments do not react, increases as disturbance amplitude grows.*

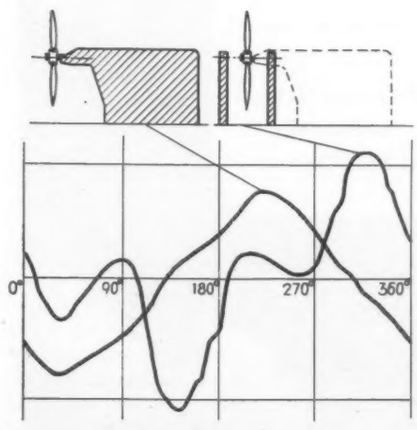


*Fig. 7. Owing to the action of impediments to airflow, such as are found on types of balancing plants formerly in general use, the angle position of the unbalance is displaced in the above measurement by nearly 90 deg.*

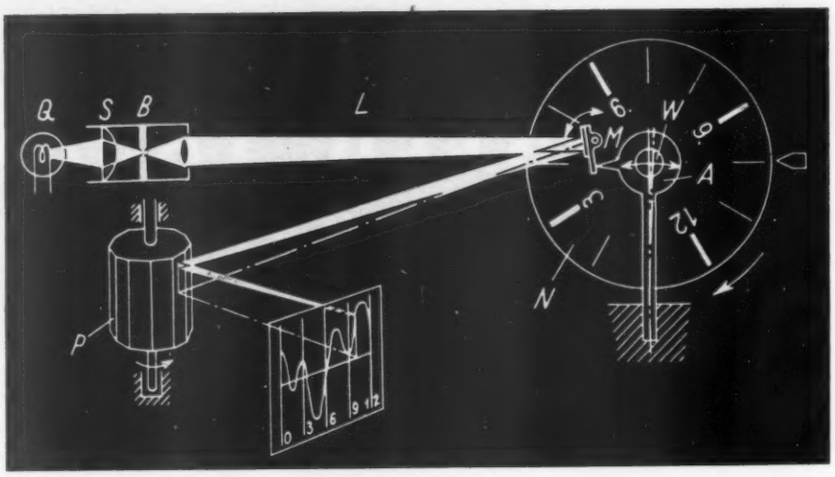


*Fig. 5. Optical observation of oscillation replaces the method hitherto employed in measuring mean values. Improvements are said to be: (1) Direct indication of angular position of unbalance, (2) measurement of smallest oscillations not perceptible with the mean value system shown in Fig. 6, (3) determination of irregular disturbances (consequence of eddies) caused by irregular and constant changes in course of oscillations.*

A dynamometer, for instance, measures its effective value as

$$x_{\text{eff}} = \sqrt{\frac{1}{T}\int_0^T x^2\, dt} = b\sqrt{\frac{1}{2}\left(1 + \left(\frac{a}{b}\right)^2\right)}$$

The curves of Fig. 7, with the disturbance amplitude **b** as a parameter, show that balancing is bound to reduce the reaction of the instrument to a minimum. The greater the disturbance amplitude, the flatter will be the minimum and the greater the remaining oscillation amplitude **a** to which the instrument barely reacts, corresponding to the reading error.

Differentiation of the above equation yields

$$x \,\triangle\, x = \frac{a_0^2}{4} \text{ and } a_0 = 2\sqrt{x \,\triangle\, x}$$

This parabola, therefore, includes the shaded area of the limit of sensitiveness of the instrument, the conditions greatly worsening in function of the increasing disturbance.

## ACCURACY OF MEASURING SYSTEM

In order to ascertain to what degree the instrument functions without friction, the oscillations as theoretically calculated were compared with the measured results. By mounting two weights on a balanced propeller its balance was upset artificially, but purely in a mechanical sense.

Bearings A and B can be left free in such a manner that they can move freely in the horizontal direction, being restored to the central position only by means of springs. In Fig. 8 bearing A is free, B fixed, but both can turn around axes perpendicular to the plane of the drawing. We shall disregard the gyroscopic action, for this only produces forces acting on the bearing perpendicular to the plane of the drawing. $\mathbf{mr}\omega^2 \cdot \cos\omega t$ are the projections on this plane of the centrifugal forces caused by the two additional masses m producing artificial unbalance. If $\Theta_B$, is the moment of mass inertia in respect of the vertical axis through B (independent of the rotation of the propeller), and

$f$ = spring constant

$n = \frac{30\omega}{\pi}$ the rpm. of the propeller

$\lambda$ = the damping constant

$\varphi$ = the horizontal angle of displacement (not the same $\varphi$ as mentioned above),

$\kappa = l\sqrt{\frac{f}{\Theta_B}}$ the angular velocity of the undamped natural vibration, then with $x = l \cdot \varphi$ the following results:

$$\varphi \,.. + \frac{f \cdot l^2}{\Theta_B}\varphi + \frac{\lambda}{\Theta_B}\varphi \,. = \frac{\mathbf{mrd}\,\omega^2}{\Theta_B}\cos\omega t.$$

Integration now yields the real forced oscillation

$$\varphi = \frac{\mathbf{mrd}\,\omega^2}{\sqrt{(\kappa^2 - \omega^2)^2\Theta_B^2 + \lambda^2\omega^2}} \cdot (l) \cdot \cos(\omega t - \epsilon)$$

The phase of this oscillation is the angle by which the heavy spot **m** (Fig. 8) is in advance of the high spot P. Here

$$\text{tg}\,\epsilon = \frac{\lambda \cdot \omega}{\Theta_B(\kappa^2 - \omega^2)}$$

Special case 1, Resonance. The reso-

(*Turn to page 244*)

# PIONEER PARACHUTES

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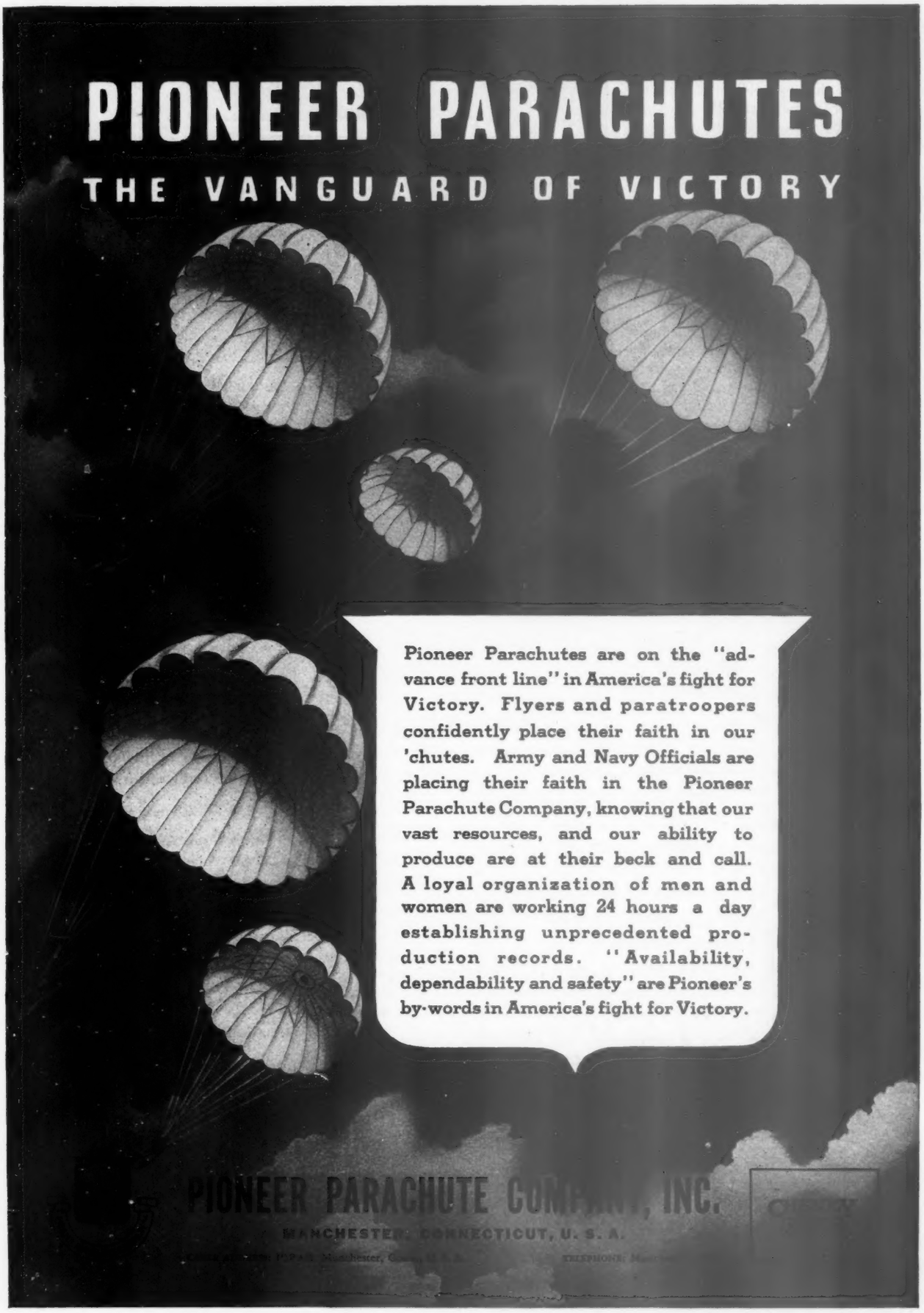

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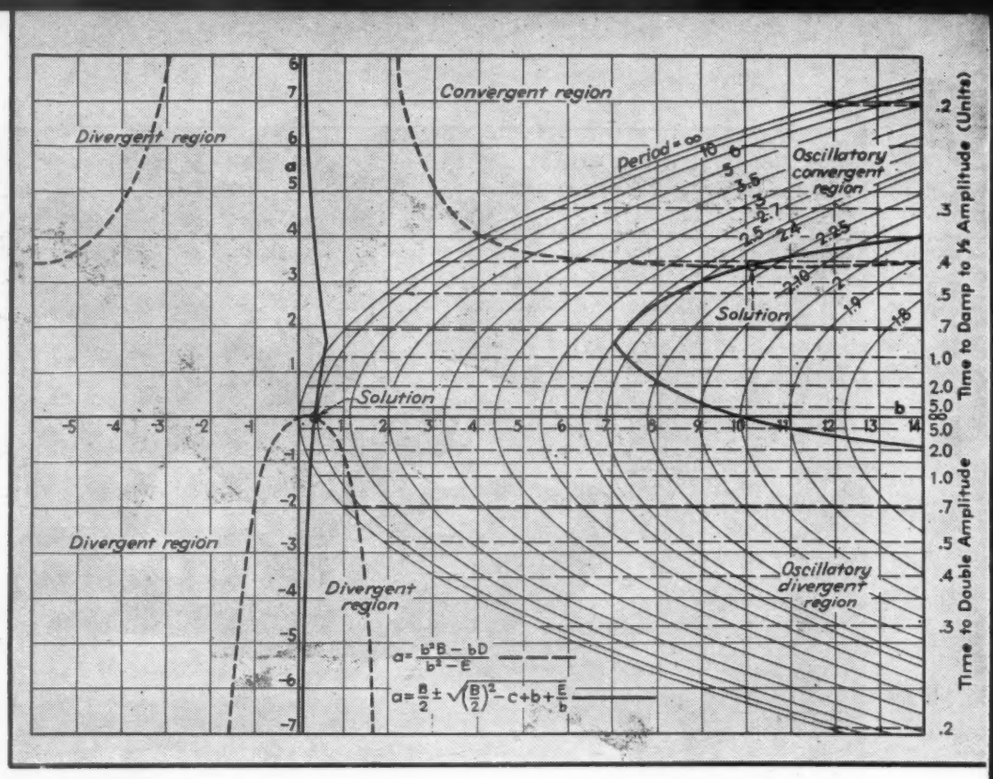



*Fig. 1. Basic chart showing lines of constant damping and constant period in non-dimensional units*

# Charting Aircraft Stability

**In this second part, the use of the stability chart is demonstrated in its application to dynamic longitudinal stability.**

**By COURTLAND D. PERKINS,** *Wright Field*

THE DEVELOPMENT of a chart for the graphical solution of aircraft dynamic stability and for portraying the trends of dynamic motion with design change was discussed in an article which appeared in the March issue of AVIATION. It was shown in this article how the chart was developed and the way it could be used to advantage by anyone interested in the dynamic power-off, uncontrolled motion of any flying configuration.

In the article referred to, the use of the chart was demonstrated in its application to lateral stability. The "spiral" and "oscillatory" mode solutions were found for a particular airplane and the effect of design changes on these modes noted. The use of this chart is of course perfectly general and by no means restricted to a study of lateral motion. In this article the use of this method will be demonstrated in its application to longitudinal dynamic stability.

The development of the longitudinal equations of motion will not be gone into as this can be found at great length in the literature. The equations will be presented only in their developed form ready for solution.

Each component of longitudinal motion varies with time according to:

$$u, w, \text{ or } \theta = C_1 e^{\lambda_1 t} + C_2 e^{\lambda_2 t} + C_3 e^{\lambda_3 t} + C_4 e^{\lambda_4 t}$$

where $\lambda_1, \lambda_2, \lambda_3, \lambda_4$, are roots of the stability quartic $A\lambda^4 + B\lambda^3 + C\lambda^2 + D\lambda + E = 0$

The coefficients of this quartic are functions of the non-dimensional stability derivatives as follows:

$$A = 1$$
$$B = -(x_u + z_w + m_q)$$
$$C = m_q(x_u + z_w) - x_w z_u + x_u z_w - \mu m_w$$
$$D = m_q(x_w z_u - z_w x_u) + \mu m_u\left(\frac{C_L}{2} - x_w\right) + \mu m_w\left(\frac{C_L}{2}\theta + x_u\right)$$
$$E = \mu\frac{C_L}{2} m_w(z_u - x_u\theta) - \mu\frac{C_L}{2} m_u(z_w - x_w\theta)$$

where

$$x_u = C_D$$
$$z_u = C_L$$
$$m_u = m_u$$
$$x_w = -\frac{1}{2}\frac{dC_L}{d\alpha}$$
$$z_w = -\frac{1}{2}\frac{dC_L}{d\alpha}$$
$$m_w = \frac{1}{2}\frac{dC_m}{d\alpha}\frac{c1}{k_y^2}$$
$$x_\theta = -g\cos\theta$$
$$z_\theta = g\sin\theta$$
$$m_q = -.63\left(\frac{dC_L}{d\alpha}\right)_t \frac{l^2}{k_y^2}\frac{S'}{S}\eta_t$$

Now by assuming the variation of pitching moment with forward speed to be zero ($m = 0$) and that $\theta = 0$ we can rewrite the coefficients of the quartic in a more familiar way:

$$A = 1$$
$$B = C_D + \frac{1}{2}\frac{dC_L}{d\alpha} - m_q$$
$$C = -\frac{1}{2} m_q\left(\frac{dC_L}{d\alpha} + 2C_D\right) + \frac{1}{2}\left(\frac{dC_L}{d\alpha} C_D - \frac{dC_D}{d\alpha} C_L + C_L^2\right) - \mu m_w$$
$$D = -\frac{1}{2} m_q\left(\frac{dC_L}{d\alpha} C_D - \frac{dC_D}{d\alpha} C_L + C_L^2\right) - C_D\mu m_w$$
$$E = -\frac{C_L^2}{2}\mu m_w$$

The following terminology is used throughout:

$$\frac{dC_m}{d\alpha} = \frac{dC_L}{d\alpha} x_{ac} + \frac{.4Lw_f^2}{Sc} - \left(\frac{dC_L}{d\alpha}\right)_t \frac{S'}{S}\frac{l}{c}\eta_t\left(1 - \frac{d\epsilon}{d\alpha}\right)$$

$$\frac{dC_L}{d\alpha} = \frac{5.7}{1 + \frac{5.7}{\pi R}} \qquad \mu = \frac{m}{\rho S l}$$

$$\frac{dC_D}{d\alpha} = 2C_L\frac{\frac{dC_L}{d\alpha}}{\pi e R} \qquad \tau = \frac{m}{\rho S v}$$

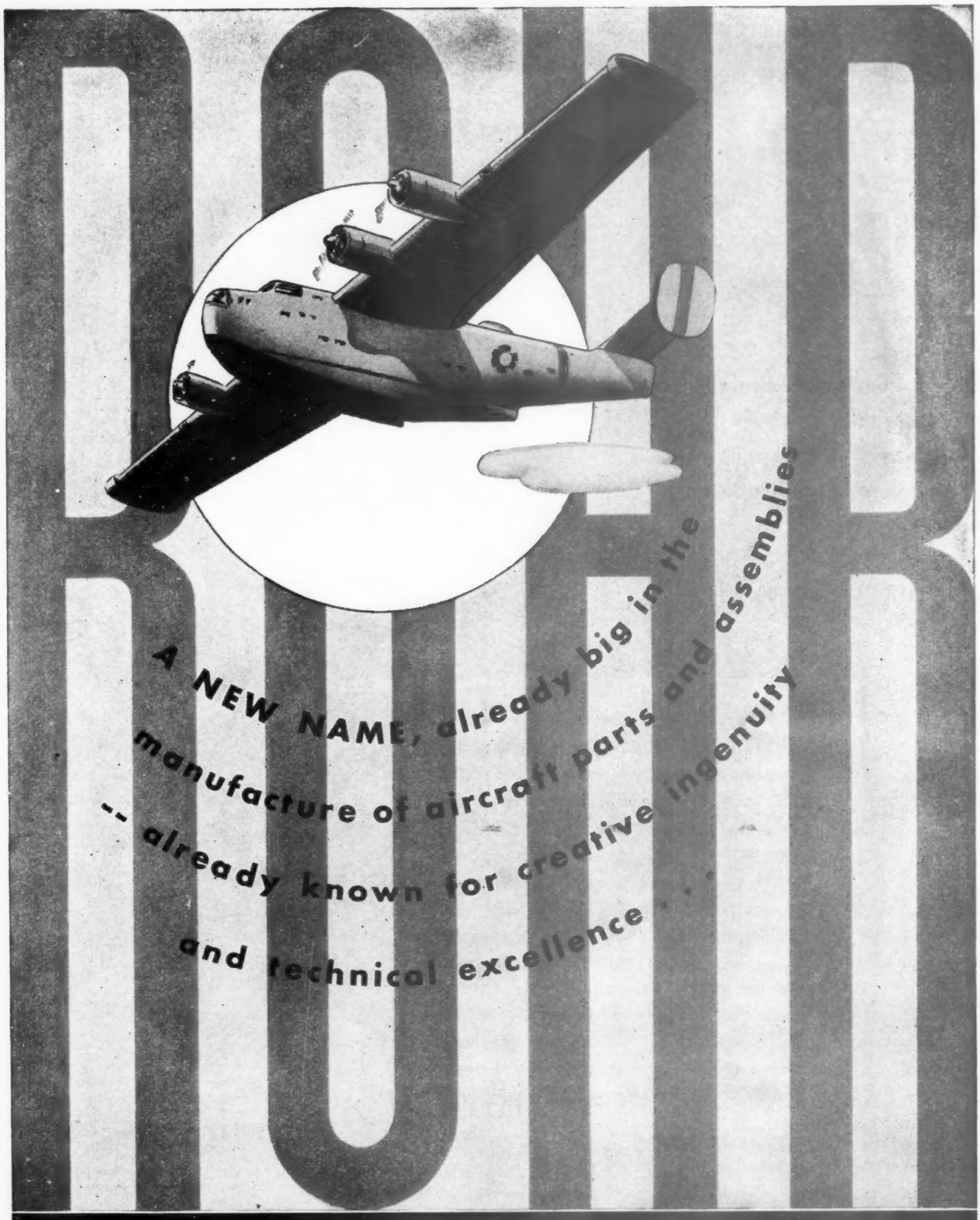
$$C_D = C_{D0} + \frac{C_L^2}{\pi e R} \qquad \frac{d\epsilon}{d\alpha} = \frac{.5}{R}\frac{dC_L}{d\alpha}$$

$$k_y = \sqrt{C_B(L^2 + h^2)}$$

where

- $L$ = overall length in feet
- $h$ = overall height in feet
- $w_f$ = max. fuselage width in feet
- $S$ = wing area in square feet
- $m$ = airplane mass in slugs
- $\rho$ = air density in slugs per cubic feet
- $e$ = airplane efficiency factor
- $S'$ = horizontal tail area in square feet
- $\eta_t$ = tail efficiency
- $c$ = m.a.c. in feet
- $R$ = aspect ratio
- $C_B$ = .04
- $x_{ac}$ = horizontal distance from c.g. to aerodynamic center in percent m.a.c.
- $l$ = distance from c.g. to elevator hinge line in feet
- $k_y$ = radius of gyration about the lateral axis in feet
- $u$ = velocity along the $x$ axis in feet per second
- $w$ = velocity along the $z$ axis in feet per second
- $\theta$ = angle of pitch in radians
- $\mu$ = airplane relative density factor
- $\tau$ = airplane time constant

All the values necessary for determination of the quartic coefficients can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be obtained from the ordinary wind tunnel, except $m_q$. The tail damping coefficient, as $m_q$ is often called, can be calculated quite readily and should not involve too great an error. Once the coefficients are determined the problem then is to solve the stability quartic.

The graphical method for solving a quartic equation was gone into in great detail in the previous article, so will not be dwelt on to any great length now. Suffice it to say that we assume the quartic can be broken down into two quadratics $(\lambda^2 + a_1\lambda + b_1)$ $(\lambda^2 + a_2\lambda + b_2) = 0$. By expanding these quadratics and equating coefficients with the quartic we eventually get two equations:

$$a = \frac{B}{2} \pm \sqrt{\left(\frac{B}{2}\right)^2 - C + b + \frac{E}{b}}$$

and

$$a = \frac{b^2B - bD}{b^2 - E}$$

Plotting these equations for values of $a$ and $b$ we get curves the two intersections of which yield the values $(a_1b_1)$ and $(a_2b_2)$ which when substituted into the quadratics yield the solutions

$$\lambda = -\frac{a_1}{2} \pm \sqrt{\left(\frac{a_1}{2}\right)^2 - b_1}$$

$$\lambda = -\frac{a_2}{2} \pm \sqrt{\left(\frac{a_2}{2}\right)^2 - b_2}$$

These are the four roots of the quartic equation sought for. A chart has been developed on which not only the solutions of the quartics can be obtained, but which determines the character of the motion immediately. The chart is shown in Fig. 1. The ordinates are values of $a$ while the abscissa are values of $b$. A parabola $a^2 = 4b$ is the boundary between oscillatory motion and pure convergence or divergence. On this chart we can immediately plot curves of constant period and damping.

$$P = \frac{2\pi}{\sqrt{b - \left(\frac{a}{2}\right)^2}} \qquad T = \frac{.693}{\frac{a}{2}}$$

Curves of constant period are parabolas about the positive $b$ axis while curves of constant damping are straight lines parallel to the $b$ axis. Damping is improved as we move away from the $b$ axis while the period is shortened as we move away from the oscillatory boundary.

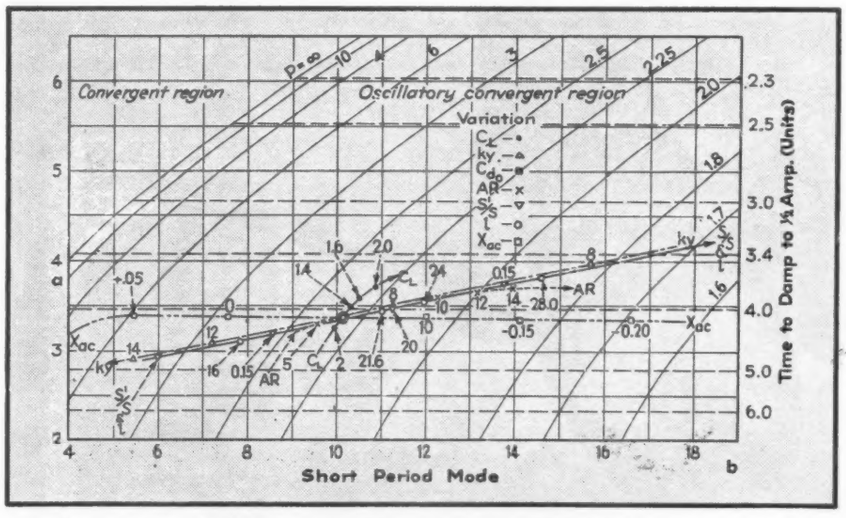
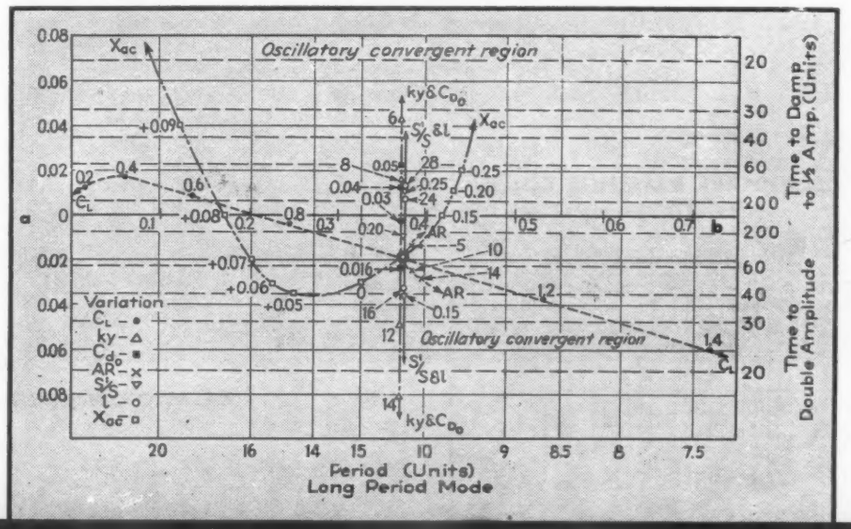



*Fig. 2. Parameter changes effecting short period mode.*

*Fig. 3. Parameter changes effecting long period mode.*




Lines of constant period and damping are shown in nondimensional time units. To convert to seconds it is necessary to multiply by the time constant $\tau = \frac{m}{\rho s v}$.

The use of this chart will be demonstrated as a method for picturing how various basic design changes effect the longitudinal motion of an airplane. To do this, a particular airplane is assumed and its motion found by the chart. Then each parameter having some effect on the longitudinal motion will be varied slowly one at a time and the new solutions plotted on the chart. A trace of the solution variation with change in parameter will then give a picture of the effect of this parameter on the motion of this airplane.

The assumed airplane will have the following characteristics:

| | |
|---|---|
| $W$ = 7680 lb. | $\tau$ = 2.01 $\sqrt{C_L}$ |
| $S$ = 384 sq. ft. | $L$ = 49 ft. |
| $W/S$ = 20 | $h$ = 10 ft. |
| $R$ = 6 | $w_f$ = 5 ft. |
| $C_{D_0}$ = .02 | $x_{ac}$ = −.0558 |
| $e$ = .85 | $\frac{dC_m}{d\alpha}$ = −.72 |
| $\frac{S'}{S}$ = .18 | $k_f$ = .4 |
| $mac$ = 8 ft. | $C_B$ = .04 |
| $k_y$ = 10 | |
| $l$ = 20 ft. | |
| $l/c$ = 2.5 | |
| $\mu$ = 13.08 | |

The motion will first be solved for this airplane when trimmed to fly at a lift coefficient of $C_L = 1$. The coefficients of the quartic for this configuration work out to be

$A = 1$
$B = 3.35$
$C = 10.433$
$D = 1.066$
$E = 3.78$

The graphical solution for the quartic with the above coefficients, is shown in Fig. 1. We find the two solutions are both in the oscillatory region. One solution is in the convergent oscillatory region at $a = 3.369$ and $b = 10.125$. This gives at once a period of 2.3 units and a time to damp to one-half amplitude of 4.1 units. To convert to seconds multiply by the non-dimensional time constant $\tau = 2.01$ giving a period of 4.62 sec. and a time to damp to one-half amplitude of 8.25 sec. The second solution is very close to the border between the two oscillatory regions. It falls just into the undamped region and this made is therefore unstable. The solution falls at $a = -.019$ and $b = .373$, giving a period of 10.8 units and a time to double amplitude of 70 units. This, when converted to seconds, yields a period of 21.7 sec. and a time to double amplitude of 141 sec.

From these solutions it can be seen that there are two oscillatory modes

(*Turn to page 256*)

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# Design Charts for Tubes Subjected to Torsion

**This is second in a series of articles on design charts for tubular members by Mr. Clayton. In the April issue of Aviation there appeared design charts for tubes subjected to bending. The use of charts for determining safe wall thickness of tubes subjected to torsional shear is described in the following.**


**By WALTER C. CLAYTON**

*Chief Engineer, Curtiss-Wright Technical Institute*


METHODS SIMILAR to those used in preparing stress analysis charts for tubes subjected to bending are applied herein to obtain design charts for tubes subjected to torsional shear. In this discussion relating to torsion the terminology used is as follows:

$D$ = Outside diameter of tube.

$d$ = Inside diameter of tube.

$F_{ST}$ = Modulus of rupture is torsion.

$f_s$ = Design shear stress = $\frac{T}{Z_p}$

$L$ = Length of tube.

$(MS)$ = Margin of Safety = $\frac{F_{ST}}{f_s} - 1$ = $\frac{T'}{T} - 1$

$psi$ = Pounds per square inch.

$R_s$ = Stress ratio = $\frac{f_s}{F_{ST}} = \frac{T}{T'}$

$T$ = Torsional moment for which tube is being designed.

$T'$ = Torsional moment which tube selected is capable of resisting.

$t$ = Thickness of tube wall.

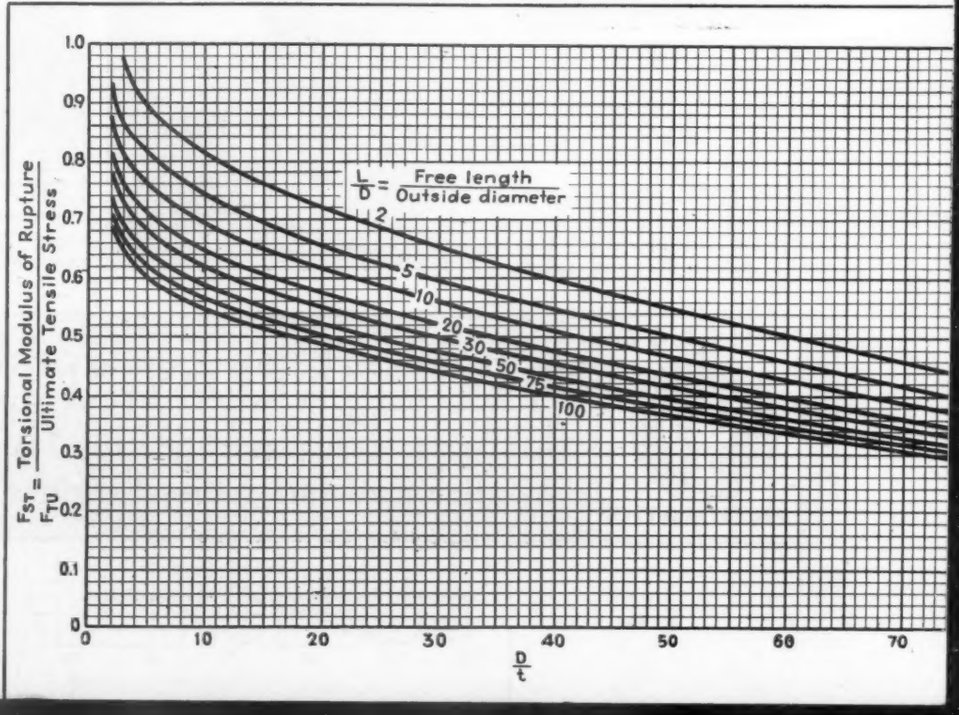
$Z_p$ = Polar section modulus = $2Z$.

In the previous article it was pointed out that the bending modulus of rupture of tubes for a given heat treatment is a function of the $\frac{D}{t}$ of the tube. Fig. 4-20 of ANC-5 contains a family of curves from which the bending modulus of rupture for steel tubes can be determined. From Fig. 4-22 it is possible to similarly determine the torsional modulus of rupture of steel tubes. The problem of the tube subjected to torsion is somewhat complicated by the fact that the torsional modulus of rupture is not only a function of $\frac{D}{t}$ but also a function of $\frac{L}{D}$ The reasons for $\frac{L}{D}$ entering into the torsion problem and not into the bending problem may not at first seem obvious. The explanation is to be found in the type of buckling that takes place in the tube wall. When subjected to bending, it is on the compression side of the tube that the buckling takes place. The tension side does not buckle. When a member subjected to compression buckles, the wall failure manifests itself in a number of diamond shaped wrinkles or folds somewhat similar to the folds in the bellows of an accordion or concertina. A longer member subjected to bending or compression has more waves or wrinkles in its wall due to the increased length, but they are of the same shape and size, hence the buckling of the wall is not a function of tube length. When the tube is subjected to torsion, these wrinkles or waves spiral around the tube. In a longer tube subjected to torsion, the wrinkles are not more numerous but are longer, hence the buckling of a tube in torsion is a function of length.

The above can be demonstrated by rolling a sheet of paper into a tube, placing one end on a table and striking the other end with his hand, thus subjecting the tube to compression. The diamond shaped wrinkles can be clearly seen. To illustrate the case of torsion, wrap the paper around two spools, one at each end. By grasping the tube at each end it can be subjected to torsion clearly showing the spiral wrinkles.

Fig. 4-22 of ANC-5 is reproduced herein as Fig. 5.* It will be noted that the torsional modulus of rupture is expressed as a function of the ultimate tensile strength. The bending charts,† Figs. 3 and 4, were obtained by multiplying the ordinates of the curves of Fig. 1 by the ordinates of the curves of Fig. 2. In a like manner, Figs. 6 and 7 have been obtained by multiplying the ordinates of Fig. 5 by twice the

*Fig. 5*. Torsional Modulus of Rupture—Round Alloy Steel Tubing*




* *Because of the continuing nature of this series of articles, all charts will be numbered consecutively. Figs. 1 to 4 inclusive appear in the first of this series published in the April issue of* AVIATION.

† *See* AVIATION, *April, 1942, page 80.*

★ ★ ★ ★ CHICAGO PNEUMATIC NEWS ★ ★ ★ ★

# NEW! SMALLEST IMPACT TYPE PNEUMATIC WRENCH

## FAST APPLICATION AND REMOVAL OF NUTS UP TO 1/4" BOLT SIZE

### Developed For Airplane Industry

NEW YORK (CP) — Chicago Pneumatic Tool Company, manufacturers of the largest line of impact type pneumatic wrenches, announces the development of the smallest pneumatic wrench — the CP 337-R. This midget among wrenches was designed especially for driving elastic stop nuts; the angle types for hard-to-get-at places. It greatly speeds the application or removal of nuts up to ¼" bolt size. Small enough to hold in the palm of the hand and lighter than any pneumatic wrench heretofore available, the new CP 337-R fits in perfectly with the trend to the employment of women in the airplane industry. Write for complete data on the 337-R and other CP wrenches.

CHICAGO PNEUMATIC TOOL COMPANY

General Offices: 8 E. 44th St., New York, N. Y.

↑ **ONLY 5 1/2" LONG,** weighing only 2 pounds, Chicago Pneumatic 337-RS is the smallest impact type pneumatic wrench. Speeds production on jobs like this ⅜" nut-running on the center wing section.

**FOR FAST WORK** in hard-to-get-at places — there's a 45° model of this new wrench — CP 337-RAF. Note how easy it is to reach the ¼" nuts on this wing section. →

↑ **THIS 90° MODEL, CP 337-RAN** speeds up nut running on hard-to-get-at jobs like this center wing section of a dive bomber. CP-337 Wrenches have all the efficiency and sturdiness of the heavier duty CP Pneumatic Wrenches.

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**AVIATION TOOLS**

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ordinates of the curves of Fig. 2. The factor, "two", enters into the calculations because the polar section modulus is twice the section modulus. It will be noticed that the ordinates of Fig. 6 and 7 are non-dimensional. The numerator consists of the torsional moment which is expressed in inch pounds, and the denominator consists of the product of the tube diameter cubed and the ultimated tensile strength of the material. Thus both the numerator and the denominator are expressed in inch pounds, which units may be cancelled out.

It is interesting to note that the ordinates of the various curves in Figs. 3 and 4 could be divided by their respective ultimate tensile strengths and similarly give non-dimensional values for both ordinates and abscissa. This the writer has done with the interesting result that the family of curves on each of these charts merge into a narrow band becoming almost one curve. Bearing in mind that these curves are empirical, having been arrived at as the result of tests, it is quite possible that all of the values could be adequately expressed by means of a single curve, as of course there is inevitably bound to be a certain amount of scatter of points resulting from tests.

Referring to Figs. 6 and 7, it is seen that each curve represents a ratio of $\frac{L}{D}$. The upper curve being for tubes whose lengths are twice their diameters. As the ratio of $\frac{L}{D}$ becomes greater, the effect of length becomes less. Thus the space between the curves $\frac{L}{D} = 2$, and $\frac{L}{D} = 5$, is several times as great as the space between the curves $\frac{L}{D} = 75$, and $\frac{L}{D} = 100$. Fig. 5-7 of ANC-5 gives three curves for the determination of torsional modulus of rupture for aluminum alloys. The effect of $\frac{L}{D}$ was not included, the values doubtless being made conservative enough to take care of a large value of $\frac{L}{D}$. This material was plotted in the form of $\frac{T}{D^3}$ versus $\frac{D}{t}$. These curves for aluminum alloy are plotted separately (Fig. 8).

The manner of using Figs. 6, 7, and 8 is similar to that of using Figs. 3 and 4. The use of the charts is best explained by examples.

EXAMPLES:

*Given:* A tube subjected to a torsional moment of 205,000 inch pounds,

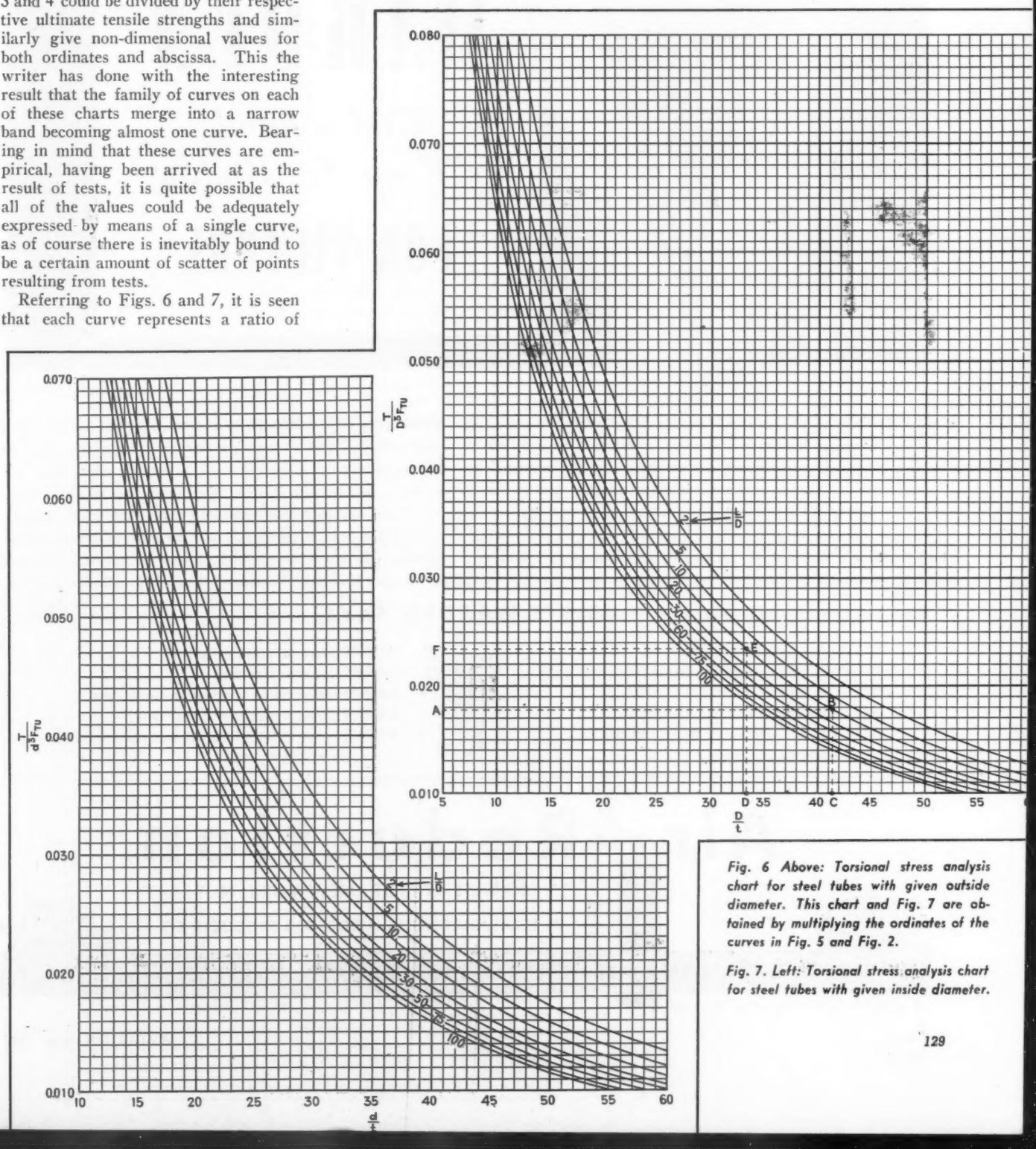
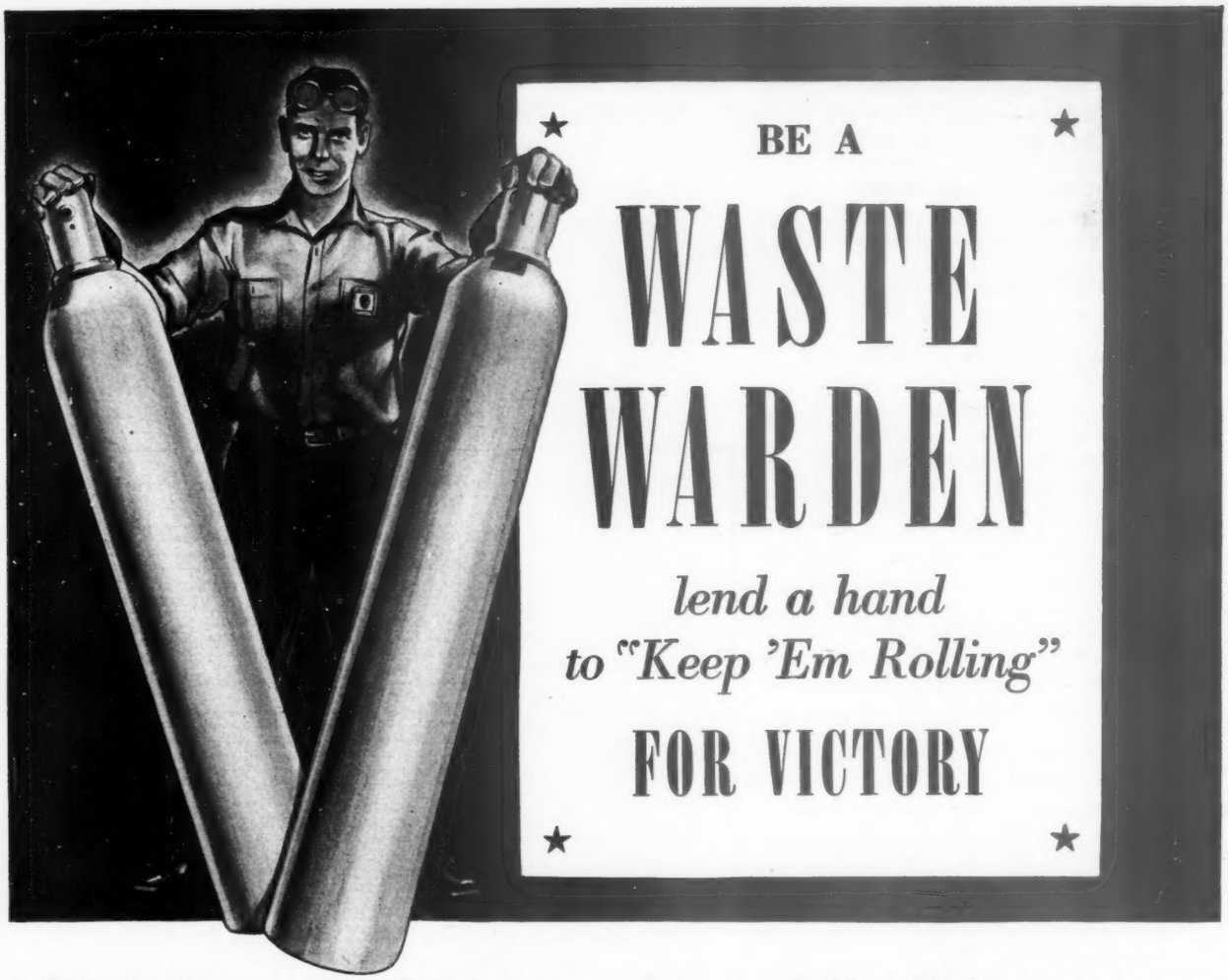



*Fig. 6 Above: Torsional stress analysis chart for steel tubes with given outside diameter. This chart and Fig. 7 are obtained by multiplying the ordinates of the curves in Fig. 5 and Fig. 2.*

*Fig. 7. Left: Torsional stress analysis chart for steel tubes with given inside diameter.*




UNCONSCIOUS waste in this land of plenty can become a serious handicap in our war effort. Let's take a case in point — oxygen. This element is vital to the speedy production of tanks, trucks, guns, ships, planes, and shells.

Oxygen consumption continues to skyrocket and the bottleneck remains steel cylinders. They just can't be obtained fast enough. But, we can all help by making every cylinder most useful. Here's how:

**Make yourself a Waste Warden.** See that the cylinders keep rolling. Don't let them get tied up in inventory. Be sure that cylinders are shipped back promptly when they are empty — and be sure to get the most gas out of each cylinder. If you see to it that these and other "do" and "don't" suggestions are followed you will be making a worthwhile contribution to our war effort as well as helping yourself.

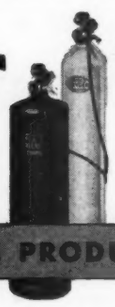
Join the "Waste Wardens". Keep the cylinders rolling.

## WASTE WARDEN SAYS:

**DO** close cylinder valve after use.
**DO** check your hose and connections for leaks.
**DO** keep inventory low.
**DO** return empty cylinders promptly.
**DO** keep tips clean and free from carbon and slag.

**DON'T** use excessive pressure.
**DON'T** use oversize tip.
**DON'T** leave tip burning when not in use.
**DON'T** abuse cylinders.
**DON'T** leave cylinder valves open when gas is not being used.

# Air Reduction



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AIRCO

WILSON

IDLE CYLINDERS ARE PRODUCTION SLACKERS: *Keep 'em rolling for victory!*

having a length of 40 in. It is desired to make this tube 4 in. in diameter. In order to keep the weight down, the tube will be heat-treated to 180,000 psi-ultimate tensile strength.

*Wanted:* (a) The required wall thickness for zero margin of safety.
(b) The margin of safety and the stress ratio, assuming that it is decided to make the wall thickness 0.120.

*Solution:*

$$(a)\ \frac{L}{D} = \frac{40''}{4''} = 10$$

$$\frac{T}{D^3F_{TU}} = \frac{(205{,}000)}{(4^3)(180{,}000)} = 0.0178$$

This point is designated as A on Fig. 6. Draw a horizontal line and extend it until it intersects the $\frac{L}{D} = 10$ curve at point B. Drop a vertical line from B to the $\frac{D}{t}$ scale at C. The value of $\frac{D}{t}$ for point C is 41.3. The required wall thickness for zero margin of safety is $\frac{(D)}{\left(\frac{D}{t}\right)} = \frac{4''}{41.3} = 0.097''$

(b) For a wall thickness of 0.120 in. the value of $\frac{D}{t} = \frac{4''}{0.120''} = 33.3$. This is point D on the $\frac{D}{t}$ scale. Draw a vertical line up to point E on the $\frac{L}{D} = 10$ scale. From E draw a horizontal line to F on the $\frac{T}{D^3F_{TU}}$ scale. Point F represents the value of $\frac{T'}{D^3F_{TU}}$, where $T'$ is the torsional moment that can be resisted when the wall thickness is 0.120 in. Its value is 0.0234. The margin of safety is determined as follows:

$$(M.S) = \frac{\left(\frac{T'}{D^3F_{TU}}\right)}{\frac{T}{D^3F_{TU}}} - 1 =$$

$$\frac{0.0234}{0.0178} - 1 = 0.315 = 31.5\%$$

When the problem involves stress ratios, it may be expressed as

$$R_s = \frac{\frac{T}{D^3F_{TU}}}{\frac{T''}{D^3F_{TU}}} = \frac{0.0178}{0.0234} = 0.761$$

It was pointed out in the previous article, that occasionally it became necessary to determine the bore of the cylinder and make the outside diameter that which is necessary to insure adequate strength. In this case we are concerned with the inside diameter $d$ instead of the outside diameter $D$. For such cases Fig. 7 is used.

EXAMPLE:

*Given:* A cylinder subjected to a torsional moment of 205,000 inch pounds, having a length of 40 in. and made of alloy steel, heat-treated to 180,000 psi. It is desired that the bore be 4 in.

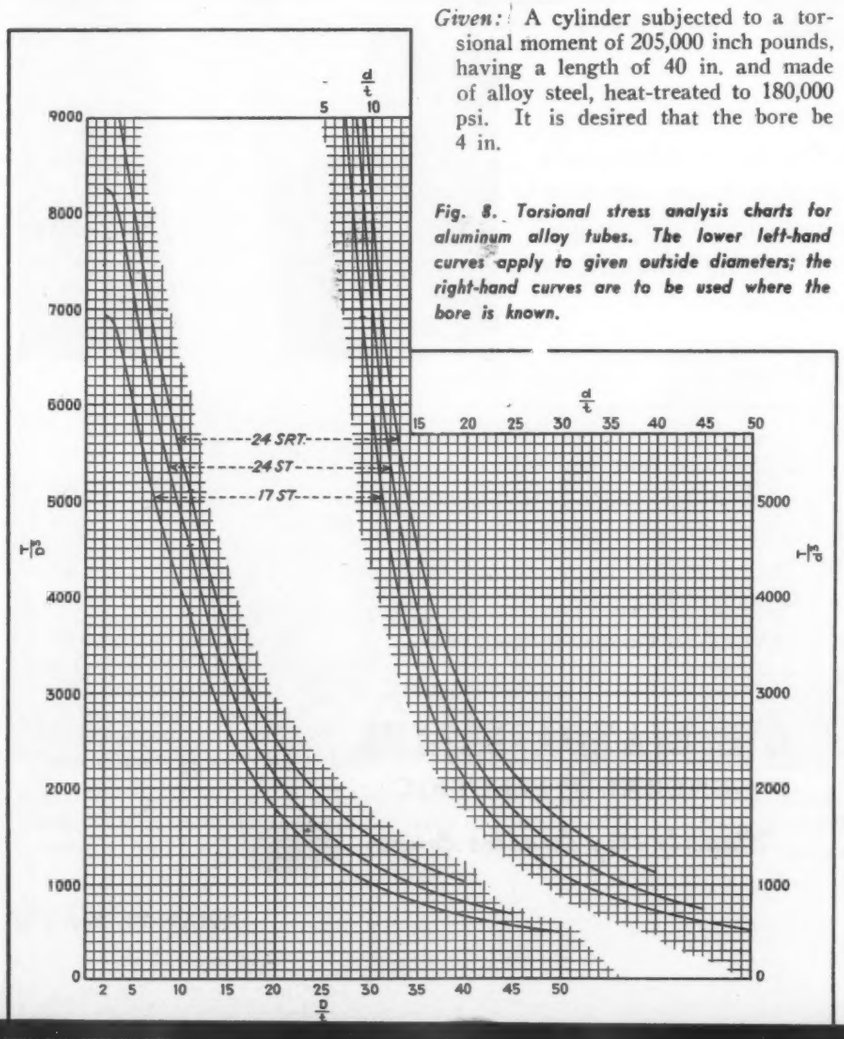



***Fig. 8. Torsional stress analysis charts for aluminum alloy tubes. The lower left-hand curves apply to given outside diameters; the right-hand curves are to be used where the bore is known.***

*Wanted:* The required wall thickness for zero margin of safety.

*Solution:*

$$\frac{L}{D} = \frac{40''}{4''+} = 10 -$$

$$\frac{T}{d^3F_{TU}} = \frac{205.000}{(4^3)\ (180{,}000)} = 0.0178$$

From Fig. 7 the value of $\frac{d}{t} = 44.3$, therefore the required $t$ for zero margin of safety is $\frac{4''}{44.3} = 0.090''$. The outside diameter would be $4'' + 2(0.090'') = 4.180''$.

A minor inconsistency might be noted on Fig. 7. We have selected $d$, the inside diameter, and we wish to determine $t$, the wall thickness. To do this we must use the ratio $\frac{L}{D}$. It therefore becomes necessary to make an estimate of the outside diameter $D$. A slight error in this regard will have only a small effect on the final results. If, however, the ratio of $\frac{L}{D}$ is appreciably different from that assumed, the work should be rechecked. In the case above, the value of

$$\frac{L}{D} \text{ is } \frac{40''}{4.180''} = 9.57.$$

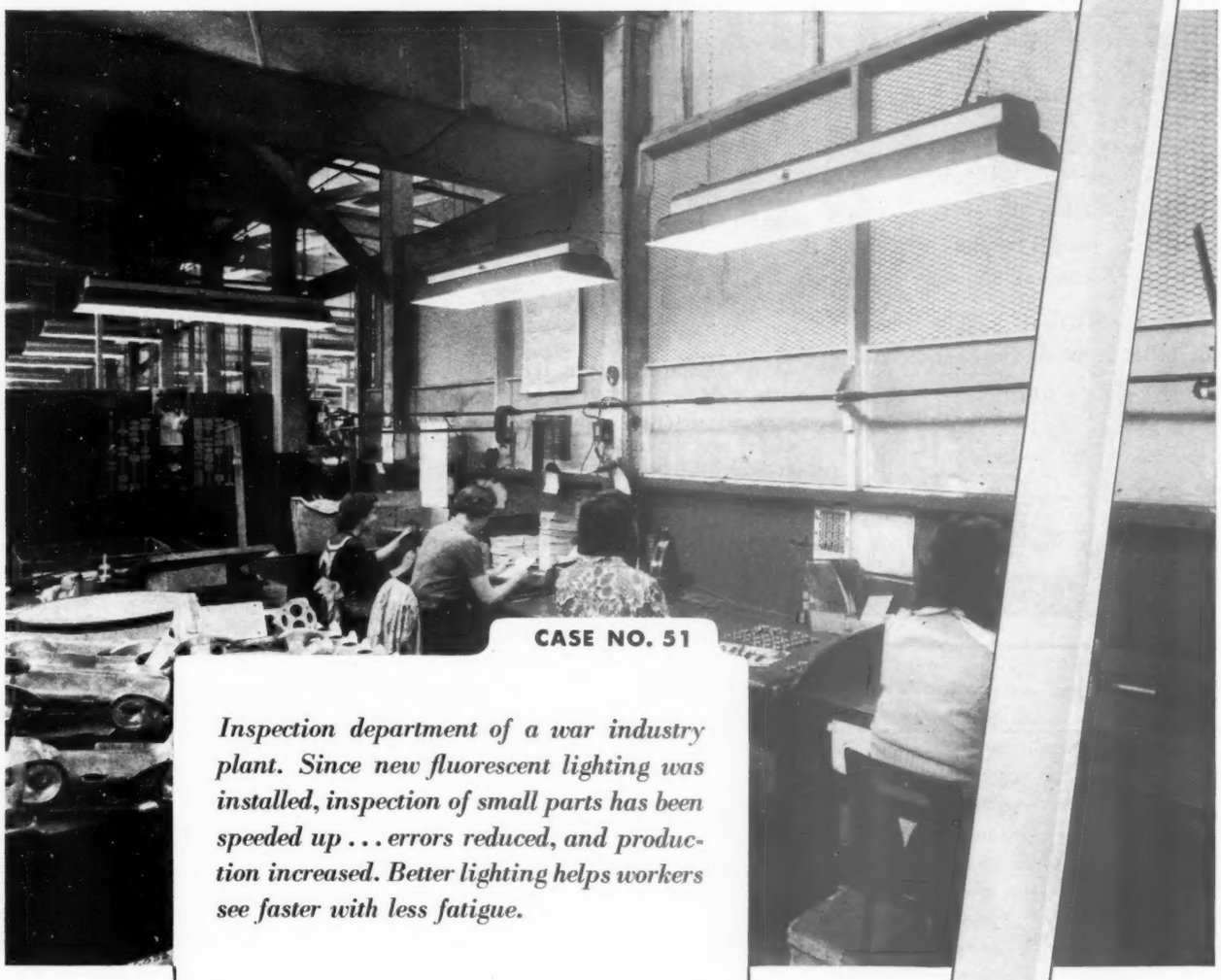
Fig. 8 represents two families of curves for use when the tube is to be made of aluminum alloy. The family nearest the lower left hand corner is to be used when the outside diameter has been determined. The family nearest the upper right hand corner is to be used for cylinders where the bore has been determined. The cross sectioning of the chart has been eliminated between these two families of curves so as to guard against the wrong scale being used.

In plotting Figs. 6 and 7, the range was cut down somewhat. None of the curves in Fig. 6 go down to a $\frac{D}{t}$ smaller than approximately $7\frac{1}{2}$ and are not extended out beyond a $\frac{D}{t}$ of 60. It will be noted that the curves of Fig. 5 from which those of Figs. 6 and 7 were derived extend from $\frac{D}{t} = 2$ to $\frac{D}{t} = 75$. It is felt that the range plotted will cover most cases encountered and that more was to be gained by plotting this range to a larger scale than by plotting to a smaller scale in order to include the extremities of the range. Frequently when a smaller $\frac{D}{t}$ is used, the member will be made in the form of a solid forging. Such cases can be solved readily, using the following formula:

$$D = 1.72\sqrt[3]{\frac{T}{F_{ST}}}$$

The values of $F_{ST}$ may be obtained from the appropriate tables of ANC-5.

# Production Up...Rejects down with G-E Fluorescent Lighting!



**CASE NO. 51**

*Inspection department of a war industry plant. Since new fluorescent lighting was installed, inspection of small parts has been speeded up . . . errors reduced, and production increased. Better lighting helps workers see faster with less fatigue.*

THE actual case described above is only one among scores of similar cases studied by General Electric to show specifically what advantages better lighting . . . in this case, G-E Fluorescent Lighting . . . offers industrial plants. War restrictions prevent giving the name and location of this factory.

If your plant is faced with the problem of how to get more and better war production without adding any extra floor space, machinery, or workmen, cool indoor daylight with G-E MAZDA F (fluorescent) lamps in certified fluorescent lighting fixtures may be the answer.

See your G-E lamp supplier or write General Electric Company, Dept. 166-AV-5, Nela Park, Cleveland, Ohio.

**G-E MAZDA LAMPS**

**GENERAL ELECTRIC**

*Made to stay brighter longer*

*Want maximum light for the current consumed? Then look for the G-E monogram on the lamps you buy.*

# Navy "E" Pennant to Pratt & Whitney

**First presentation for aircraft engine production**

FIRST PRESENTATION for aircraft engine production of the Navy "E" —the blue and white pennant symbolizing excellence in production achievement —was made to the Pratt and Whitney Aircraft Division of the United Aircraft Corporation at East Hartford, Conn. Rear Admiral John H. Towers, chief of the Bureau of Aeronautics, a score of top ranking Navy and Army officers, officials of the War Production Board and representatives of the aircraft industry and the company's management attended the ceremonies.

More than fifteen thousand Pratt and Whitney workers, whose unflagging efforts were responsible, according to the company officials, for the winning of the award, were spectators of the event which took place March 23, 1942. Four veterans of the company's earliest days now still at work in the plant, were selected to receive from Lt. Commander R. M. Oliver, Naval aircraft inspector, the small buttons bearing the symbolic "E" which they accepted on behalf of their fellow workers.

The entire aircraft industry can take pride in the award made to Pratt and Whitney, Admiral Towers said in his speech that preceded the formal raising of the pennant, pointing out that the award had been made for services that far exceeded any called for in the written contracts. The enthusiastic comment that had greeted the announcement of the award to Pratt and Whitney, Admiral Towers declared, was proof that the Navy's choice in making its first citation in the aviation industry had been a popular one.

"The creation and development of any machine so superb as the Pratt and Whitney engine entails an unsung saga of triumph over the impossible, by skill, will and sheer grit," the Admiral said. "All of you here on the payroll today have had some part in the winning of this award."

"From men like Henry Cudworth, Alex Hokanson, Henry Gunberg, Francis Downey and the Navy's own J. G. McGarvey," the Admiral said, naming the veterans who were to receive the "E" buttons for the employee group, "down to the youngest trainee on the job, each of you can rightfully claim his share of the honor, each according to his talents, his strength and his will to serve."

For over 80 years, the Navy "E" has been a goal towards which the men and officers of the fleet have striven, the Admiral noted, as a visible reward of their excellence and proficiency in special fields. Only those ships which attained the highest standing in gunnery, navigation or engineering were awarded the "E," and their right to continue the possession of the pennant has periodically to be proven. Two years ago, as the national defense program placed a greater burden on the civilian firms supplying the Navy, the award was broadened to include those companies which had given outstanding service.

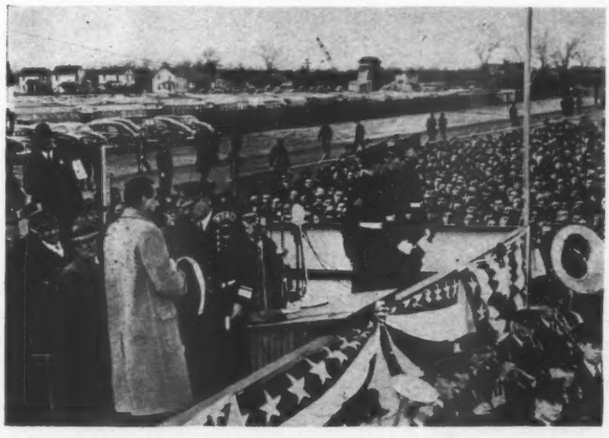
H. Mansfield Horner, general manager of Pratt and Whitney, in making the speech of acceptance for the management and workers, acknowledged the cooperation of the Navy's Bureau of Aeronautics and the resident Naval inspector and staff. He added that without the closest cooperation on the part of the vendors and subcontractors of Pratt and Whitney, the exacting job of meeting the expanding schedules of the defense program could not have been accomplished.

Acknowledgement of the importance of the cooperation of the Pratt and Whitney workers during the emergency period was given by the top officials of the company, including Frederick B. Rentschler, chairman of the board, and Eugene E. Wilson, president, in a press conference that preceded the afternoon's events. Although one of the major worries at the outset of their defense expansion had been whether the employees would cooperate, the management officers agreed that the workers had risen to the emergency in every way possible.

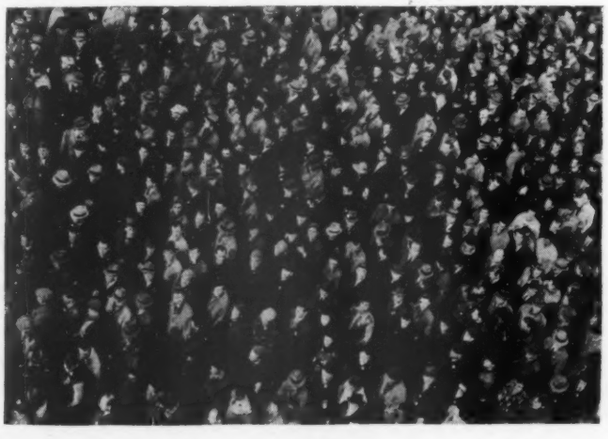
A fourfold expansion of the Pratt and Whitney plant had taken place since the beginning of the program, Mr. Wilson revealed, while its personnel expansion has been sevenfold. The resulting increase in the monthly production rate has been twelvefold, it was stated. Each of these jobs, Mr. Wilson stated, was a tremendous accomplishment, yet they were all worked out in the same period of time that the large automotive plants required to convert their facilities to wartime production.

The three outstanding companies in the automotive field which are now cooperating in the production of Pratt and Whitney engines are using engineering and production methods which are basically the same as those developed at their own plant, Mr. Wilson stated, giving proof of the essential soundness of the methods developed by the Pratt and Whitney engineering staff.

From its beginnings in 1925, the company has been closely associated with the development of aviation in the United States Navy, a brief historical note carried in the printed program for



*Navy's "E" Pennant flies above speakers' stand as Rear Admiral Towers, Chief of the Bureau of Aeronautics, makes presentation talk to workers of Pratt & Whitney engine factory at East Hartford, Conn.*



*Some of the thousands of Pratt & Whitney workers who helped win the Navy award for production achievement as they watched the presentation ceremonies.*

the day, pointed out. The 400 hp. Wasp, the first Pratt and Whitney engine, was designed specifically to meet the needs of the Navy for an aircooled engine of limited weight, and the success of the early Wasps was largely responsible for the Navy's historic decision to standardize on the aircooled engine. To keep America ahead in the world-wide race for power in the air, Pratt and Whitney developed next the higher-powered Hornet. These two engine types were the basis of a long line of notable single-row powerplants. Pratt and Whitney followed them by pioneering with the development of the two-row radial type engines, the Twin Wasp, and the Twin Wasp Junior. Newest addition to the Pratt and Whitney line is the 2000 hp. Double Wasp engine.

More than a million hours of successful operation in the Navy service lies behind Pratt and Whitney engines, it is authoritatively stated. Today they are operating from the decks of every United States aircraft carrier and from the catapults of battleships and cruisers, and from Naval bases all over the world.

"Most of America's planes now fighting in the Pacific area are powered with Pratt and Whitney engines," Admiral Towers revealed to the crowd that watched the flapping blue and white pennant rise to the top of the flag pole, for the first time in honor of an American aircraft firm.

With that statement the Admiral summed up all the reasons why the Navy had chosen this traditional method to say "Well done, Pratt and Whitney!"

## Engine Lab on Wheels

One of the most valuable items in Boeing's large storehouse of aeronautical research developments is a solitary airplane engine at the Seattle plant that roars and roars but never leaves the ground.

It's a real engine, mounted on a real section of airplane wing; but in place of fuselage and tail section, the wing is attached to a house. The whole works is mounted on wheels and runs on a rail, but it doesn't go anywhere. It just runs around in circles. The circle, however, stays in the same place.

The "go-round" house was built to test the engine installation of new type planes without flying them, and under conditions that will take into consideration the direction the wind is blowing. Since the engineers couldn't control the wind and couldn't take time to wait for it to change direction, they simply set the lab on a turntable. If the engine is to be tested heading into the wind, as on a normal take-off, the laboratory can be obligingly trundled around to face the proper compass point.

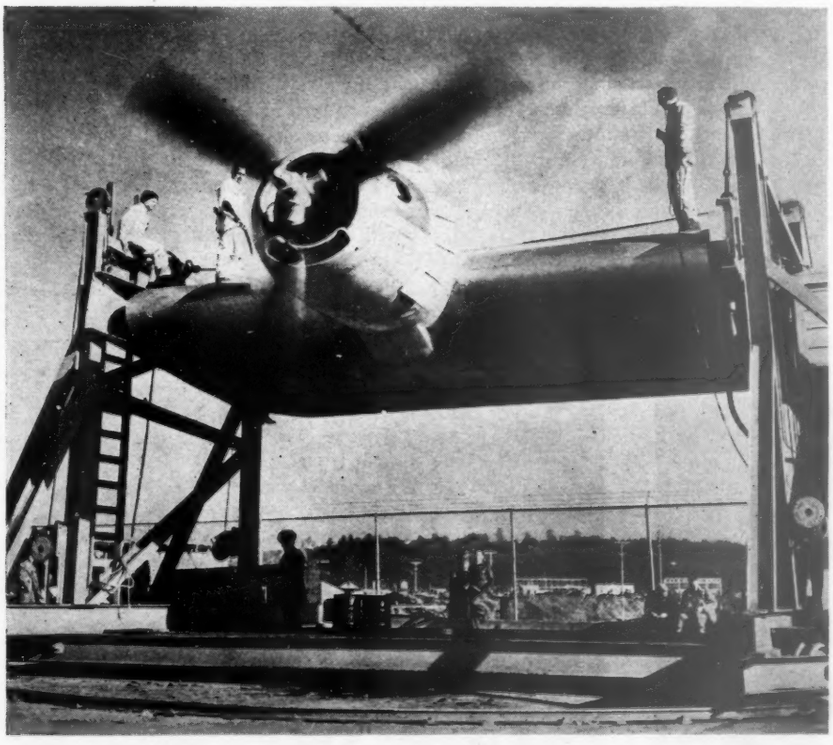
An important reason for testing the engine under ground conditions is that an airplane motor is put to its greatest strain, normally, during the warm-up and the take-off. The way it operates and the way it cools can be judged to considerable extent, therefore, before the engine ever is put in a plane.

Another reason for ground testing is a natural outgrowth of the first. Since, with proper facilities, you don't actually need to fly an engine to see how it will operate during the normal period of greatest strain, you can save thousands of dollars and weeks of testing time if you have completed the warm-up and taxiing tests while you are still building the rest of the plane.

Some of the things that can be checked in the Boeing revolving laboratory are oil cooling, fuel flow, exhaust back pressures, vibration of the engine and the propeller, prop clearances and how well the heat generated in the cylinders is dispelled. More than showing only how the engine will operate on the ground, the results are a good indication of what may be expected in the air, it is said.

The largest cooling problem is apt to be encountered at ground level. In the air, for instance, a plane usually cruises at from 60 to 70 percent of its engine capacity. But on the ground, during warmup and takeoff, the engines are speeded to full horsepower. In flight, the plane sets up its own headwind as it hurtles through the air; on the ground there may be no wind, and the temperature may be 100 deg. or more.

The tests are conducted by the "flight" crew inside the merry-go-round lab. The cabin is sound-proof and equipped with instruments just like a plane's cabin, as well as with manometer boards to measure pressures at many points, cameras for recording the whole board readings at the same instant, and other gadgets for getting the desired information about what's going on inside the running engine.



*Engine test laboratory at the Boeing plant in Seattle designed to put airplane engines through rigid performance tests without taking them off the ground. The lab is mounted on wheels which run on a track, permitting the engine to be shifted to take advantage of wind from any direction.*

## Electrical Tester

A new production tool invention, the Universal Electrical Tester, which reduces the time required to check complex electrical installations on various Lockheed planes from 8 or 10 hr. to only 15 min., is the work of John E. Browne, Lockheed plant engineering. While working as electrical inspector in precision assembly, Browne designed and had built by the plant engineering dept., an electrical tester which duplicates ship operation of all electrical sub-assemblies equipped with plugs, determining continuity of circuits, short-circuits, etc.

Use of the Browne electrical circuit

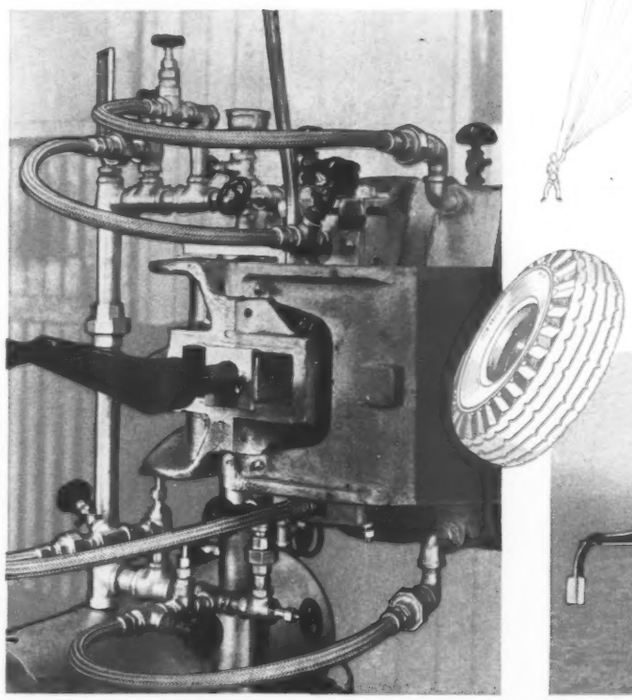
# The RIGHT Flexible connector for countless "WAR" applications

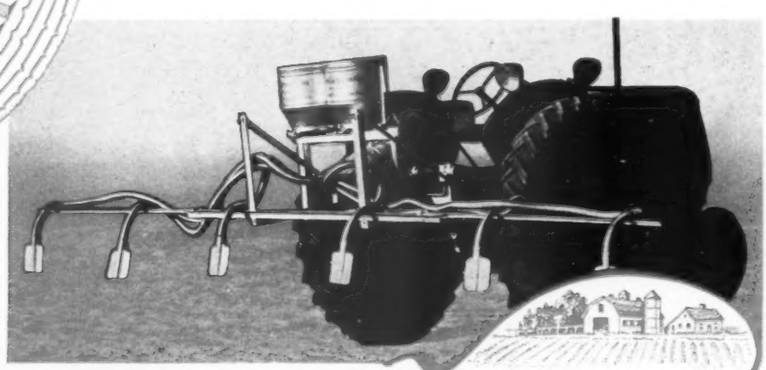
In addition to inherent flexibility, American Flexible Metal Hose and Tubing has that rare quality *flexibility of application* which makes inevitable its use in jobs where less adaptable flexible connectors cannot survive. Plane builders use it to protect aircraft radio sets from low tension static interference; in the form of parachute rip cord housing it guards the lives of our nation's pilots. Insecticides sprayed through flexible metal hose protect growing plants. Tire recapping machines are supplied with live steam.

And so it is—wherever moving parts of machinery require connectors to convey steam, water, lubricants; wherever gases, liquids, solvents must be carried safely without leakage, you will find American Flexible Metal Hose.

In thousands of such duties the products of AMERICAN are standing up . . . and speeding up, under twenty-four hour punishment. Whatever or wherever the job — you will find tough, tight, dependable American Metal Hose serving and saving.

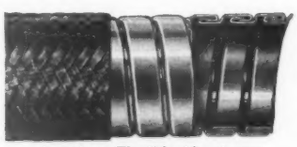
SEE ASSEMBLIES ON NEXT PAGE





American Square-Locked Flexible Metal Tubing, cord packed.

American Seamless Flexible Bronze Tubing.



American Flexible Aluminum Shielding Conduit.

NEW BULLETIN

Contains full data and specifications on American Metal Hose aircraft products—flexible low tension shielding conduit and fittings—flexible aluminum and stainless steel tubing — ferrule attaching machines, etc.

If you are interested send for your copy of Bulletin A-48. For any use of American Flexible Metal Hose and Tubing we shall be glad to supply bulletins which give complete details.

American Metal Hose

ANACONDA

AMERICAN METAL HOSE BRANCH of THE AMERICAN BRASS COMPANY

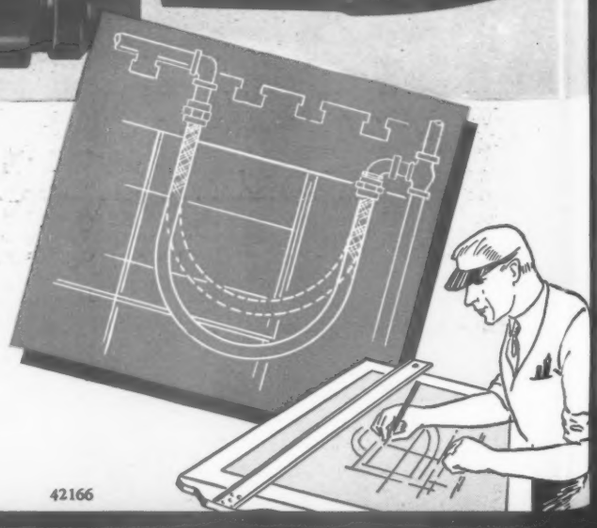
*General Offices: Waterbury, Conn. • • Subsidiary of Anaconda Copper Mining Company*

*In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

## PLAN *EARLY* FOR *FUTURE* PERFORMANCE

Machine designers . . product engineers . . the best time to plan for the use and benefit of American Metal Hose and Tubing is during the early stages of development.

The assemblies shown above have solved many problems of production, and increased the operating efficiency of products. They have reduced costs, decreased maintenance . . . and provided neat streamlined design. Send for Bulletin A-48 for the Aircraft Industry. Ask us also for specific recommendations or bulletins covering *any* use of American products.



**AMERICAN METAL HOSE BRANCH of THE AMERICAN BRASS COMPANY**

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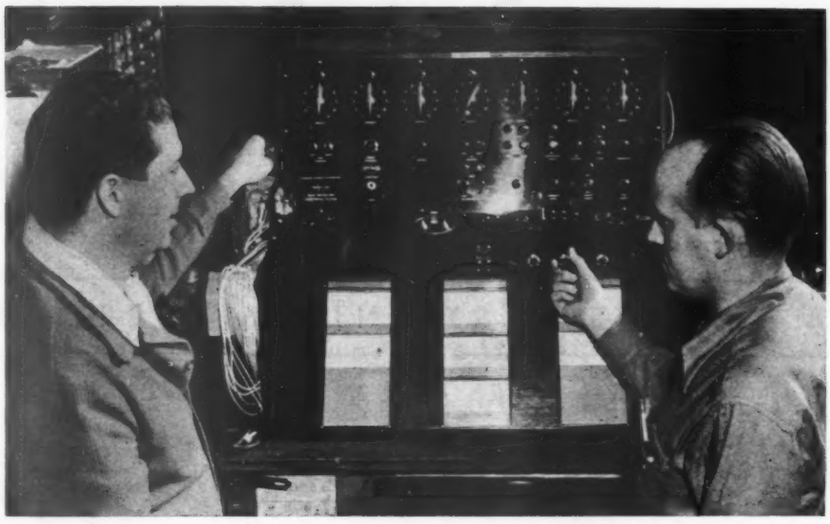
*In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

42166

tester makes it possible to transfer bench testing to the installed master switch box and its related circuits. Hundreds of wires pass through this switch box and there are many detachable plugs and receptacles with as many as 36 contact pins on one plug. And there are about 100 loose wires which go out through various conduits to fuse panels and equipment.

The Browne electrical tester checks all wires for shorts to the frame of the box and indicates by a red light those that are shorted. It checks all plug terminals for shorts to the shell and to adjacent pins, indicating by lights which are shorted and where. All switches in the switch box operate on the tester as in the ship and each switch has a separate light on the test panel to indicate if it is properly wired. Master testers are being developed for each individual plane now in production.



*John E. Browne, Dept. 1, Lockheed Plant Engineering, left, and his Electrical Tester which checks all electrical equipment in a fraction of the time formerly required.*

## Steel Frame Containers for Aircraft Parts

As a result of long experience gained in shipment of automobile body parts, Fisher Body has developed a new method to insure safe transport of bomber sections.

In shipping automobile body parts such as roofs, door panels, floors, etc., Fisher Body had devised in recent years, steel frame containers which materially lessened the danger of damage in transit. These containers now have been converted by Fisher Body for shipment of aircraft sections from fabricating plants to final assembly. This method effects not only important conservation of materials, but a reduction as well in the idle time of freight cars used for aircraft shipments.

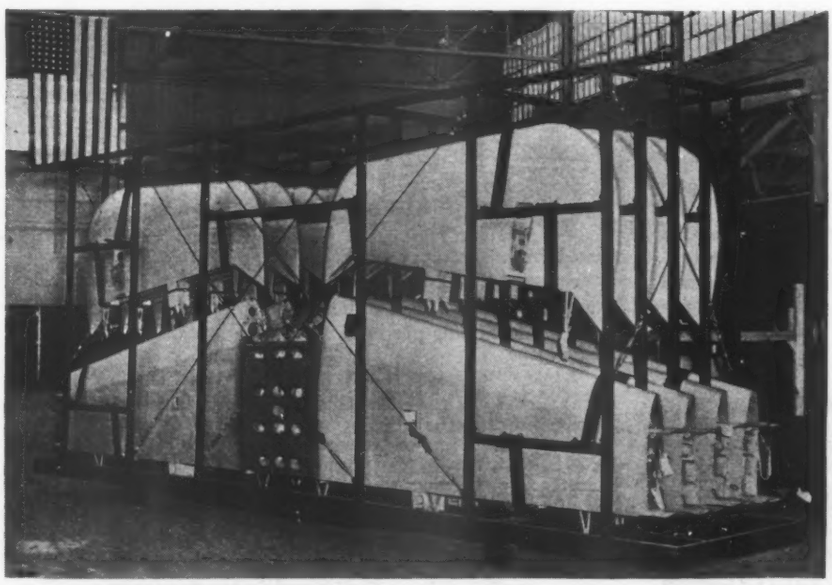
Plane part transportation formerly was handled by means of wooden crates built around the sections to be shipped. In shipment of sections built on a mass production basis such as Fisher Body now has undertaken, however, it was found that wooden crates would require excessive frame construction work, heavy charges because of the greater weight, and the complete loss of the wooden material at the destination, since it would be impractical to return the crates for repacking.

Shipments by wooden crates, according to E. F. Fisher, general manager, required from two to three pounds of dunnage for each pound of goods. The new steel containers have lowered that ratio to about 1.5 lb. of dunnage to one pound of goods.

Furthermore, since the steel containers are used over and over, there is no loss of dunnage after each shipment. It has been figured that for shipment of all bomber parts called for in the existing Fisher Body contract, only one ounce of steel will have been used as dunnage for each one pound of aircraft part shipped. The conservation of materials in the one ounce to one pound ratio is obvious.

Within the Fisher plant where bomber parts are built the containers are loaded with wings, rudders, stabilizers, ailerons, or whatever parts are to be shipped. Each part is held in place with strong but elastic straps which tend to absorb any impacts incurred during transport. The containers are equipped with a type of rubber-mounted "knee-action" casters to lessen the danger to their valuable cargo while being rolled in or out of cars.

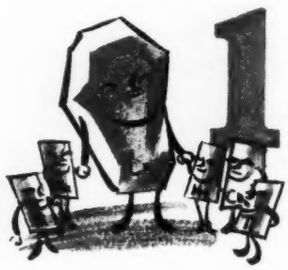
One important feature of the containers is the method of fastening them securely within freight cars. Several containers are shipped in each car, depending on their length, and cars used for this purpose are equipped with special brackets. These firmly grasp the containers at each end while a horizontal jack between the containers keeps them securely locked within the brackets. This device gives strong protection against either forward and backward or up and down motion, while trucks in which containers' casters are locked prevent sidewise sway.



*Parts for bombers are shown here carefully packed in special shipping containers ready to be transported to another plant for final assembly.*

# Basic Facts about
# STAINLESS STEELS

## A STAINLESS STEEL PRIMER



**STAINLESS STEELS**

are corrosion-resistant steels containing at least 12 per cent chromium with or without other alloying elements, such as nickel, manganese, molybdenum, columbium or titanium. They are supplied in a wide range of analyses.

The stainless steels vary in corrosion resistance, workability, wear resistance, and physical properties according to the amount of chromium, carbon and other modifying elements present.

**VALUABLE PROPERTIES INCLUDE:**

Good corrosion and oxidation resistance . . . varying almost in direct proportion to the amount of chromium present.

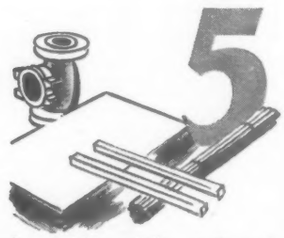
High strength-weight ratio in some cold-rolled types permitting fabrication of strong, light-weight trains, aircraft, and other structures.

**MAINTENANCE**

of stainless steels is simple. Washing with soap, household cleanser, and water will keep the surface bright and free from surface deposits.

**FABRICATION**

is accomplished by almost all common methods. They can be machined, spun, deep-drawn, forged, punched, stamped, and otherwise mechanically-worked. They can be welded by all the common welding methods. If the austenitic steels are stabilized with columbium or titanium, and columbium-bearing welding rod is used, no annealing is necessary after welding.



**MANY FORMS**

are available in the common analyses including sheet, plate, strip, tubing — both seamless and welded — bars, wire, cable, welding rod, and a variety of cold-rolled shapes. Stainless steel is also supplied as foundry castings.

**APPLICATIONS**

of stainless steel are numerous. Because of their resistance to corrosion and oxidation, as well as their high strength and bright surface, stainless steels have been used in hospitals, chemical plants, oil refineries, railroad trains, aviation equipment, and power plants. In the present emergency, they are available only for those industries participating in war production.

• • •

Although we do not make steel, we have for more than 35 years produced "Electromet" ferro-alloys and metals used in making steel. With the knowledge accumulated from this experience, we are in a position to give impartial advice. If you have a specific problem concerning the manufacture, fabrication, or use of stainless or other alloy steels, consult us without obligation.

**Electromet**
Trade Mark
**Ferro-Alloys & Metals**

**ELECTRO METALLURGICAL COMPANY**
*Unit of Union Carbide and Carbon Corporation*
30 East 42nd Street UCC New York, N. Y.
In Canada, Electro Metallurgical Company of Canada, Limited, Welland, Ontario.

# Efficient Aircraft Print Checking

**This system improves accuracy and serves to coordinate design and production problems.**

By **EDWIN WALD,** *Engineering Department North American Aircraft Corporation*

THE CHECKING GROUP serves principally in a functional capacity. Tracings which are to be looked over by a member of the checking department are routed through the printing department and a special check print is made. Generally, on new tracings, a number of check prints pertaining to a specific assembly in the airplane are grouped under one job. A checker is assigned the job and he goes through each print in detail determining what corrections should be made. The check prints are then returned to the draftsmen or designers who made the tracings and the checker's recommendations are reviewed. Obvious errors are corrected without question, but problems of an intricate nature may or may not be worked out in complete accordance with the checker's recommendations, When the tracing has been corrected, it is reviewed and signed by the checker and passed on to his supervisor for approval.

The checking routine can be broken down into a few major approaches on the basis of the fact that several types of tracings pass through the group. They are redrawn tracings, redrawn and revised; revised; and new tracings.

When an old tracing is redrawn, the new tracing is checked to see that it is identical with the obsolete one. An effective check is accomplished by checking off each item considered with a colored pencil. Correct items on the check print (from the new tracing) are lined out in yellow, incorrect items are noted in red. Further, the obsolete tracing can be checked lightly with red. Thus discrepancies and omissions are reduced to a minimum.

A tracing which has been redrawn and revised receives the same consideration as a tracing which has been redrawn without change with the exception that the revisions are looked into and correlated with all parts affected. Revisions are largely checked against engineering orders or drawings change requests which have accumulated. Any discrepancies or weaknesses are pointed out on the check print before it is returned. In the case of tracings which have been revised without being redrawn, a check print may not be made and corrections are noted on a piece of paper which can be clipped to the tracing. Special attention is given to shop practice so that the revised print will cause a minimum of change in the production of the part or parts shown on the print.

Often new tracing are an adaption of similar parts, however, the work must be thoroughly looked into. Essentially the tracing is checked against existing information. That information is in several forms.

### ALL RELATED PRINTS CHECKED

Often design layouts are available which give sufficient information to establish a partial check. However a completely satisfactory check is not achieved until the new print has been checked against all other available prints describing parts near or attached to the part under consideration. When the new print is checked against existing prints the fact is established that the part will fit and operate satisfactorily as far as dimensional considerations are concerned.

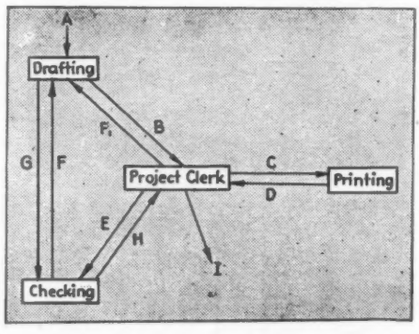
There are a number of considerations involved besides purely dimensional checks. These include a balance between desired precision of results and increasing cost and difficulty of production operations; the effect of the tolerances on the fit and operation of the parts; proper dimensioning to reduce piling up of tolerances; and a consideration of the nature of the machining operation both in the manner of dimensioning and in the designation of the tolerances.

Attention is given to the design of the parts as to structural requirements, operation of the mechanism if any, and materials from which the parts are made. The stress group gives specific consideration to structural requirements, but the checking group supplements the analysis and assumes a more significant role in minor structural parts which the stress group is not greatly concerned with. Sometimes by alterations in design, simplifications can be made both in the parts and in mechanism operation.

### TIME LOSSES AVOIDED

Another consideration of importance is the feasibility of the assembly. The goal to achieve in the assembling of parts is to develop the most economical assembly units. Units that are hard to work on should be avoided as should repetition of effort. Assembling, disassembling, and reassembling wastes time and proper assembly units reduce lost time to a minimum.

Attention is given to the drawing to see that minimum drafting standards are attained, that the views are in agreement, that the drawing is in scale, and that the bill of materials and title block are properly completed. The drafting room manual is used as a reference for stock available and North American procedures and standard practices. Commercial catalogues and army-navy standards are also used as references.

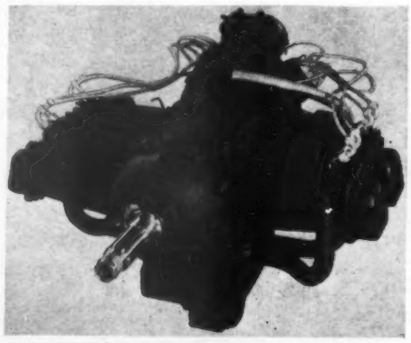



**Flow Chart of Checking System**

A. Preliminary layouts for new tracings; or drawing change requests and engineering orders to be incorporated on old tracings.
B. Completed tracings to project clerk.
C. New and redrawn tracings to printing department.
D. Tracings and check prints returned to project clerk.
E. Jobs sent to checking.
F. Checked prints or tracing returned to drafting for correction as each job checked (redraws may be returned to project clerk and then to drafting).
$F_2$. New and redrawn tracings returned to drawing.
G. Corrected tracings (new, redrawn, revised) and check prints returned to checking.
H. Completed job returned to project clerk.
I. Tracings leave project clerk to be released and printed.

## New Franklin Four Completes Tests

Aircooled Motors' four cylinder geared engine, model 4ACG-199, which has completed its ATC tests recently,



*Franklin 4ACG-199 115 hp. geared model.*

*Keeps Production Hurrying!*

**P&H's HONEST DELIVERY DATES WILL BACK YOU**

Handle it "thru the air"—the fast and easy way to keep vital production *on the move.* Save time of skilled workers—save energy otherwise wasted in lifting heavy loads—with this outstanding small electric hoist.

At the push of a button, P&H Zip-Lifts put anything in exactly the place you want it. They're designed to handle loads "thru the air" with speed, safety, and economy—and keep doing it year after year!

And you can count on getting your Zip-Lifts on time. P&H hasn't missed a single delivery date in almost a year. Bulletin H-20 tells all about P&H Zip-Lifts—write for a copy today!

**CAPACITIES: 250, 500, 1000 lbs.**

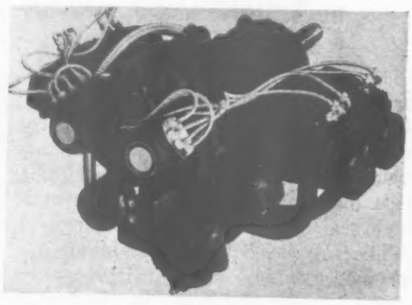
P&H ZIP-LIFT

*General Offices:* 4593 W. National Avenue, Milwaukee, Wisconsin

**HARNISCHFEGER CORPORATION**

HOISTS • WELDING ELECTRODES • MOTORS P&H EXCAVATORS • ELECTRIC CRANES • ARC WELDERS


develops 115 hp. for take-off at 2200 rpm. The standard finished engine is equipped with electric starter and solenoid starter switch, an engine-driven generator with two-stage voltage regulator and cut-out, dual magneto ignition, breather pipe, carburetor, exhaust flanges and gaskets. Dry weight of this horizontally opposed, wet sump Franklin, as described, is 248 lb.



*Three-quarter rear view of latest Franklin to complete ATC tests.*

*JAPHAPPY*

TOKIO TALKS—*Posters like these in Douglas Aircraft Company's California plants tell America's production troops why they must conserve the precious materials that make airplanes. Hundreds of such posters, together with special movies and shop demonstrations, have enabled Douglas employees to go far in conquering the "waste material" problem, thereby saving valuable time and increasing vital production. Scores of combat aircraft are being salvaged literally from the floors of the plants and sent into the skies. Proportion of scrap to raw material fell 12 percent from 1940 and 40 percent from 1939.*

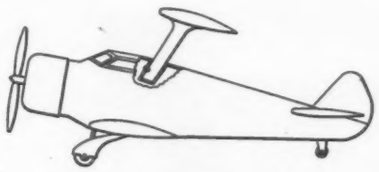
## Patents Review

The following recent patents on aviation developments have been announced by the U. S. Patent Office:

**Bomb-carrying Mechanism for Airplanes.** No. 2,273,724. Richard H. Nelson, et al., Seattle, Washington, assignors to Boeing Aircraft Company.—An interior rack and releasing mechanism and arrangement for carrying bombs in such a way that they may be released singly or in sticks, but will drop in a manner not to be made public.

**Air Speed Indicator.** No. 2,274,262. Irving Wolff, Merchantville, N. J., assignor to Radio Corporation of America.—A device for indicating velocity including a source of sound waves, a pair of pickup devices responsive to such sound waves, and means connected to pick-up devices for indicating the velocity of the medium passing the source of the sound waves.

**Airplane,** No. 2,277,242, V. S. Makaroff. An auxiliary wing which may be discarded in flight, after decrease of fuel or bomb



load, to increase speed and maneuverability. Permits bomber to escape or fight more effectively.

**Parachute apparatus,** No. 2,275,114, Floyd Smith, assignor to Irving Air Chute Co., Inc., Buffalo, N. Y. Parachute harness adapted to remain tight, or to tighten if loose, during the actual drop. This would permit the harness to be worn comfortably loose during flight previous to jump.

**Airplane aileron,** No. 2,275,692, Edward Sims. An aileron control adapted to control ailerons together or separately so that they can act as brakes for landing, elevators for takeoffs, and balancers during flight.

**Heavier-than-air craft,** No. 2,275,777, G. M. B. Lane, et al. An auxiliary wing adapted to increase the lift of the craft without materially increasing the aerodynamic resistance, when not in use remains in recess in main wing.

**Landing hook for aircraft,** No. 2,276,312, Kurt Jurschick, assignor to Avado Fluzzenwerke Geselischaft mit beschränkter Hoftnung, Brandenburg, Hasse, Germany.* A tail brake hook, for airplanes, which engages a brake rope and then closes so as to ride over other brake ropes, this permits a more even braking action.

* German patents granted were applied for before the war started. The property rights of nations and their nationals are not recognized in time of war; therefore, any enemy patents wanted by the United States Government or by U. S. aircraft manufacturers would be confiscated, and settlement after the war would be in accordance with treaty.

All patents granted are reviewed by an Army-Navy committee before release for publication. Therefore any patents involving principles thought to be unknown to the enemy, and having great military value, are withheld.

**Landing wheel mounting for aircraft,** No. 2,276,466, E. W. Cleveland, assignor to the Cleveland Pneumatic Tool Co., Cleveland, Ohio. A mounting for tail or nose wheels which while using a telescoping shock absorbing construction is also adapted to pivot about its verticle axis.

**Wing system for airplanes,** No. 2,276,522, Franz Stauffer, assignor to Dornier Werke G.M.B.H. Friedrichshafen-on-the-Bodensee, Germany. A landing flap system made in two, and in some instances three, parts which combined together present a smoother surface both while in extended and in retracted position.


V

Production means Victory

"YANKEE" VISE

Speeds Production

**War means all-out production. All-out production demands the tools that can stand the punishment of ceaseless hours, endless work and still speed up the job. The "Yankee" Vise is just such a tool. Here's why:**

1. **Sides, front end, and base are milled for interchangeable and accurate positioning on face plate or machine bed.**
2. **Detachable swivel base permits the vise itself to be transferred from bench to machine for drilling, tapping, or milling operations—and back to bench again.**
3. **Quickly, easily, and economically converted into milling, drilling, and tapping jigs.**
4. **Hardened steel block with V-shaped grooves, furnished as standard equipment, holds round stock securely.**

"Yankee" Vises are made in four jaw widths and two styles. No. 991–1½"; No. 992–2"; No. 993–2¾"; No. 994–4". These same sizes with the detachable swivel base feature are Nos. 1991, 1992, 1993, 1994.

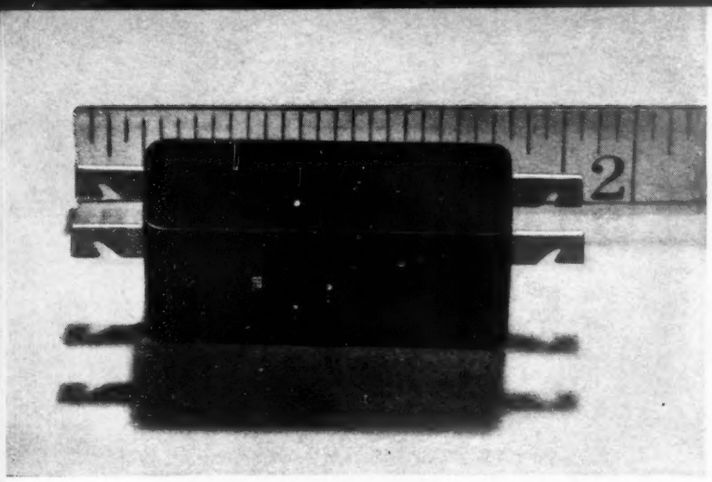
*Order from your supply house or write North Bros. Mfg. Co., Dept. A5, Phila., Pa. Every effort is being made to reach a balance between supply and war-time demand.*

"YANKEE" TOOLS

make good mechanics better

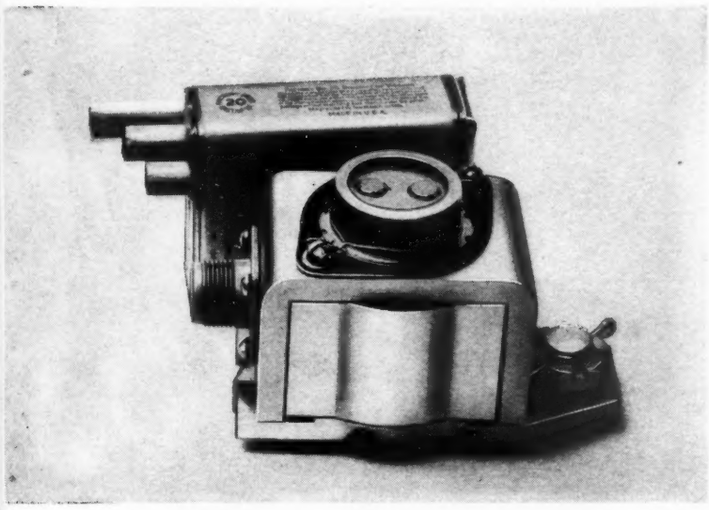
North Bros. Mfg. Co., Phila., Pa., U. S. A.

Established 1880

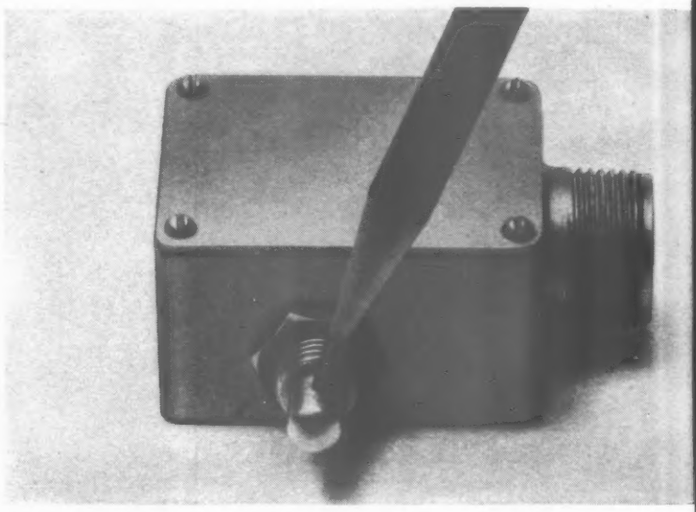


**G-E Switchette** Weighs 9 grams; measures 1¾ in. x ½ in. x $\frac{13}{32}$ in.; comes in either single-circuit or two-circuit form, and provides one normally open or one normally closed contact, or both one normally open and one normally closed contact; has double-break contact construction. See Bulletin GEA-3818 for further information.

**Sensitive D-C Relay** Weighs 3¼ ounces; has a maximum continuous rating of 2 amperes at 32 volts, d-c, and a maximum make or break rating of 10 amperes; provides single-pole, double-throw contact arrangement. Sealed aluminum cover protects relay from dust and against damage from rough handling. Detailed description in Bulletin GEA-3819.



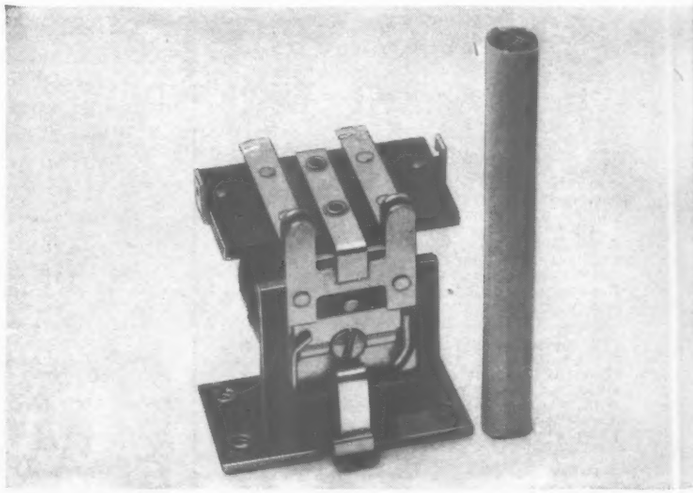
**Aircraft Solenoid** (Type G-9) Weighs 2.1 pounds; operates on 4.3 amperes at 24 volts, d-c, in 20 C ambient temperature. Built to meet U. S. Government specification. Complete details given in Bulletin GEA-3820.



**Limit Switch** Weighs 2.15 ounces; contact mechanism is the G-E switchette; has 7/32 in. overtravel; measures approximately 2⅜ in. x 2 in. x 1⅛ in. For full information about this sturdy, aluminum-housed limit switch, see Bulletin GEA-3821.

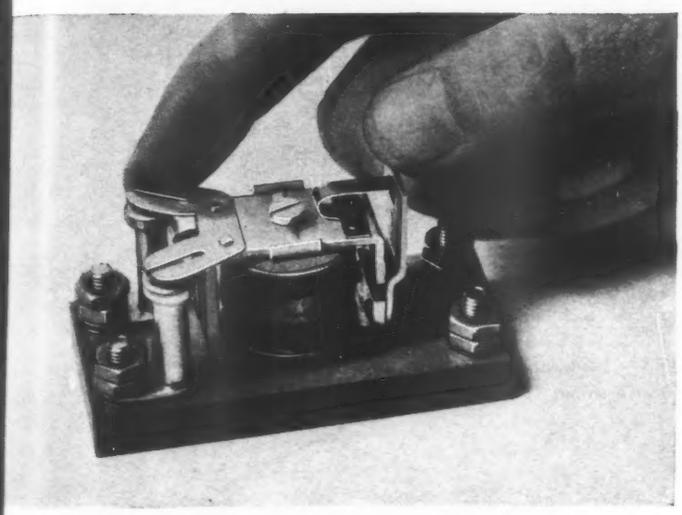
# G-E Aircraft Controls Meet These U. S. Govt. Requirements

1. Navy 200-hour salt-spray test
2. U.S. Govt. vibration stipulations
3. Operate at rated current up to 40,000 feet altitude
4. Withstand linear acceleration of 10 G applied in any direction
5. Operate at temperatures from −40 C to 60 C or 95 C

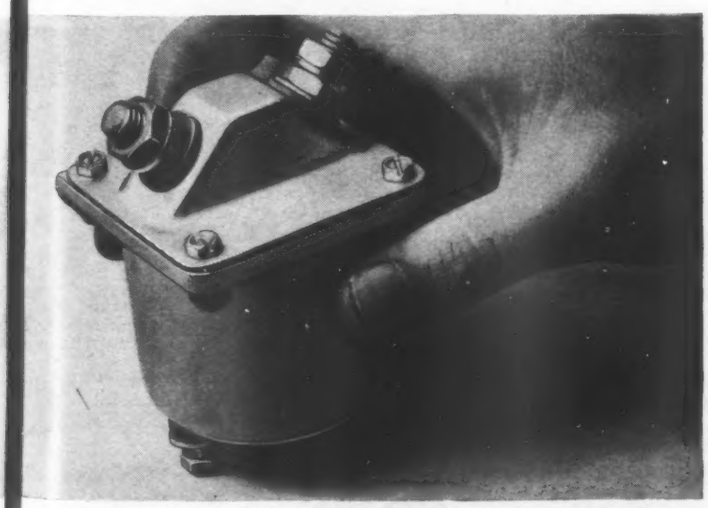


**Single-pole Relay** Weighs 3.7 ounces; has a maximum continuous rating of 20 amperes at 12 or 24 volts, d-c; provides one normally open, or one normally open and one normally closed contact. Two-pole and three-pole forms of this relay are also available. Bulletin GEA-3813 gives complete details.

# General Electric *now offers* Aircraft Controls



**Single-pole Relay** Weighs 6.1 ounces; has a maximum continuous rating of 25 amperes; at 12 or 24 volts, d-c, and a maximum make or break rating of 100 amperes; provides one single-pole normally open double-break contact. Detailed description in Bulletin GEA-3815.



**Dynamotor Contactor** Weighs 2.3 pounds; operates on 12 or 24 volts, d-c; handles an inrush of 500 amperes at 28 volts; provides one single-pole normally open contact; has a 50-ampere rating based on the NEMA 8-hour test. Bulletin GEA-3812 gives full information.

**General Electric announces** a line of control devices for aircraft electric systems. Most of the devices shown here are already in production; others will be shortly. Our Research Laboratory, our designers, and our manufacturing organization are pledged to meet the rigid standards of today's fighting ships.

## If You Don't See What You Want...

*ask for it*

A new and fast-moving industry calls for the development of many new electric products. We invite you to bring your special control problems to our *Industrial Control Division.* Its engineers will gladly discuss with you the design of new electric control devices to meet your needs.

*General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.*

**WRITE FOR OUR NEW BULLETIN**

**General Electric, Sect. B676-72, Schenectady, N. Y.**

**Please send me a copy of your new bulletin which gives complete descriptive information about all the control devices for aircraft electric systems that you now have available.**

**NAME**.....

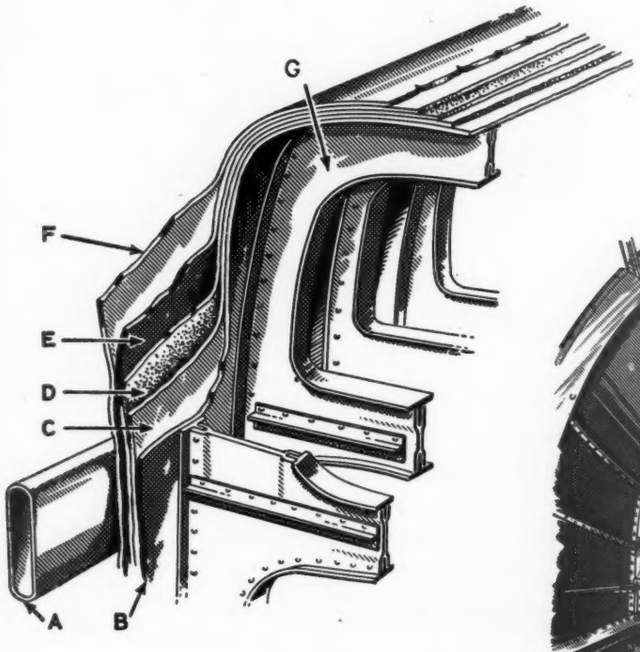
**COMPANY**.....

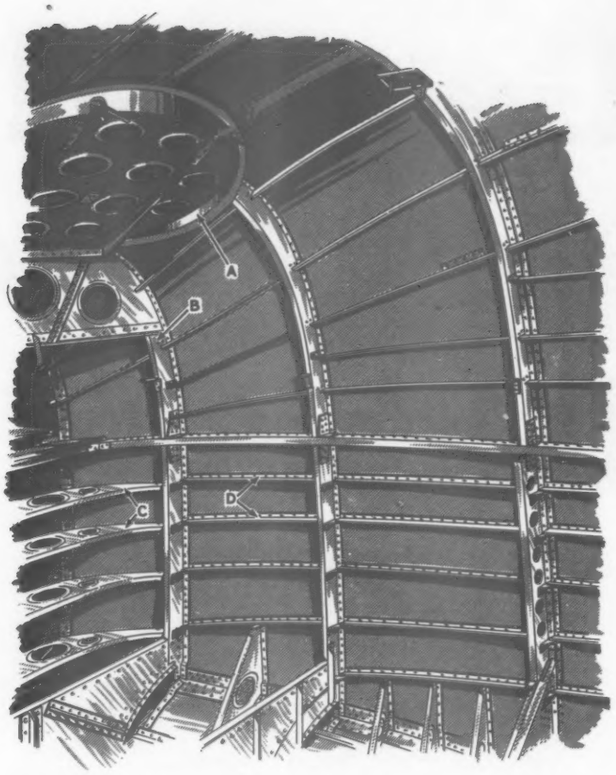
**ADDRESS**.....

**CITY**..... **STATE**..... 676-72

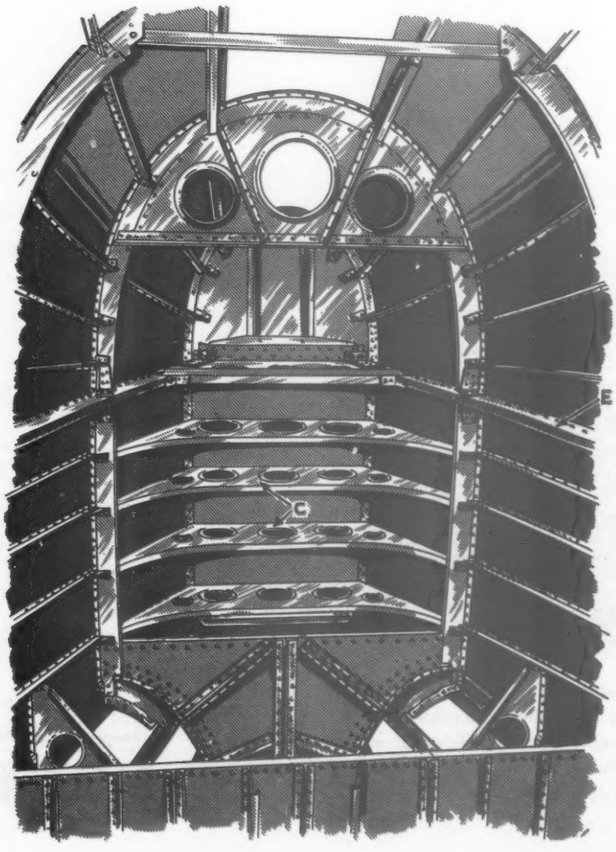
**GENERAL ELECTRIC**

In the cross-section of the Messerschmitt Me 110 fuel tank, below, a tough, rigid, vulcanized fibre cradle "A" encircles the tank in the chord plane as a support. The tank wall is composed of five layers, which from the fuel side outward are a pressed or molded fibre shell "B" 1/16 to 3/32 in. thick; a 1/8 in. thick layer of tanned leather "C"; 3/16 in. layer of plasticized raw rubber "D"; 1/64 in. layer of tightly-cured, nearly pure rubber sheet "E", and a cover of highly-loaded, black vulcanized rubber 1/8 to 3/16 in. thick "F". "G" is an I-section riveted fibre rib to which the molded fibre shell "B" is cemented. The ribs serve both as structural members and partial baffles. This tank construction weighs 3 lb./sq. ft. as against 2 lb./sq. ft. for most American tanks. Also, the fibre shell splits considerably under gunfire, allowing the liquid to act over a large area, and the tank cannot be readily repaired, but must be replaced after being subjected to gunfire. (Courtesy Vultee Aircraft)



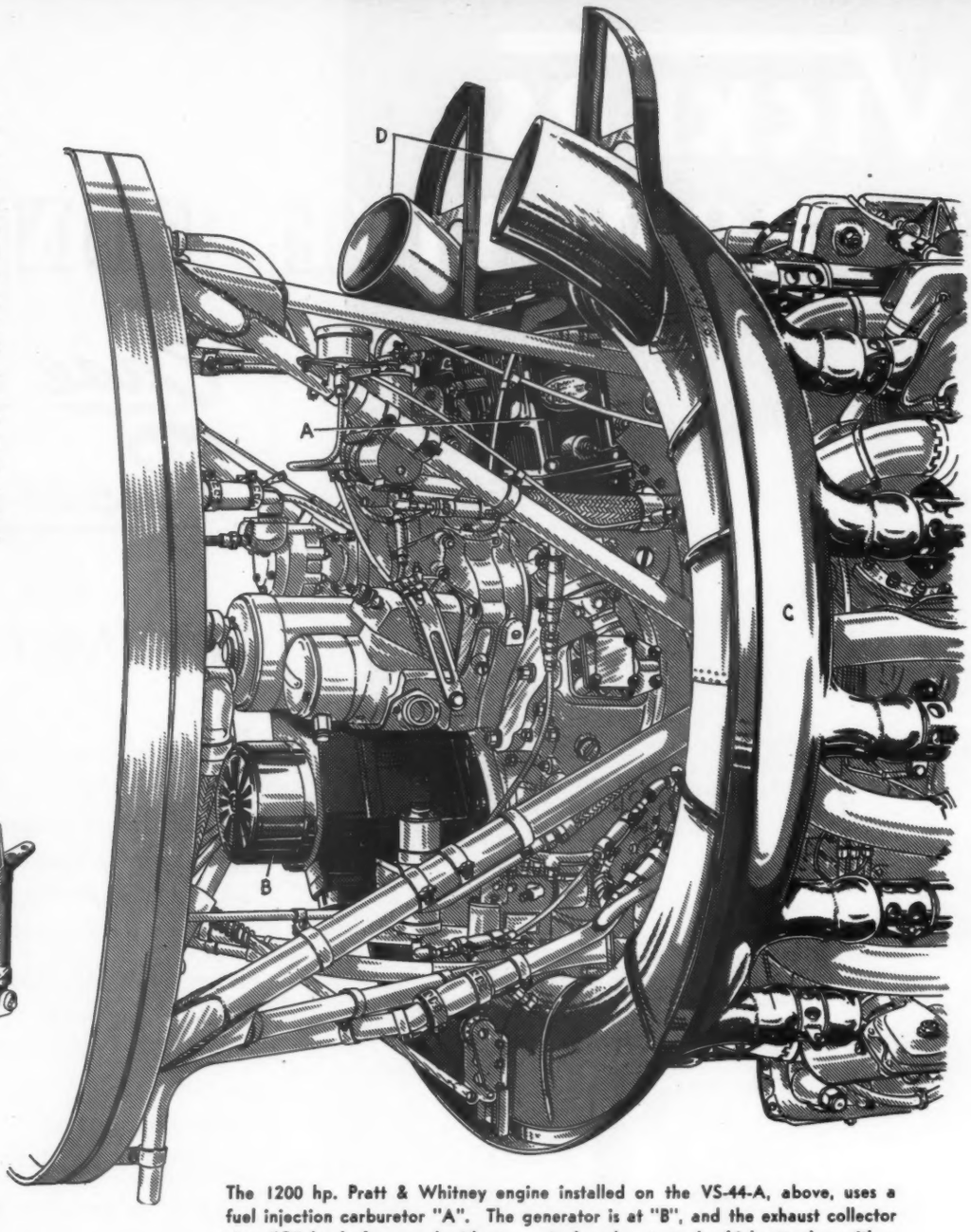




The interior of the bow compartment of the Vought-Sikorsky flying boat is shown above. The hatch entrance at the nose is located at "A" and is attached to the nose bulkhead "B". Attached to this bulkhead also are the nose reinforcing horizontal bulkhead "C". These are designed to distribute loads applied directly to the bow to the stringers "D" which join the bulkhead "B" at the same point on the rear side.

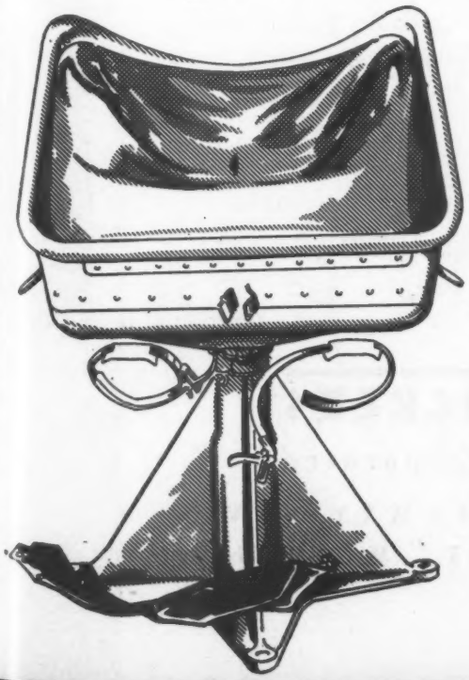



This view of the VS-44-A bow compartment, right, shows the nose frame installation. The horizontal reinforcing bulkheads "C" are shown as well as their attachment, and the main horizontal longeron "E".

A hydraulically-operated, fully retractable main landing gear is used on the Messerschmitt Me 110 pursuit plane. The partially exploded view, below, shows the hydraulic cylinder connecting to the center of the knee strut. Compression of this cylinder lifts strut and wheel into retracted position behind automatically operated doors in the engine nacelle. The hydraulic system uses a maximum working pressure of about 2,000 lb./sq. in. A compressed air system provides for emergency actuation, with air stored in small cylinders at approximately 2,200 lb./sq. in. The landing gear mechanism is simplified by automatic locks, for extended and retracted positions, built within the actuating cylinders. (Courtesy Vultee Aircraft, Inc.)




The 1200 hp. Pratt & Whitney engine installed on the VS-44-A, above, uses a fuel injection carburetor "A". The generator is at "B", and the exhaust collector ring "C" leads from each side to a single exhaust stack which attaches with a Y-fitting at "D".



Construction of the gunner's seat in the Messerschmitt Me 110 is simple, comprising three main parts: sides, bottom, and mounting post. Shown in front and side views, left and right, the bottom and mounting post are light-metal sand castings, and appear unnecessarily heavy. The top is a stamping .064 in. light-metal sheet, the upper edges being rolled around a 5/8 in. dia. aluminum alloy tube to form a large bead. Two stowage brackets are mounted under the seat. The seat back is designed to permit the gunner to lean far back when firing upward, and, although none too comfortable, provides ample free movement. The mounting post is attached to the aircraft structure by four bolts passing into nut plates under the floor, in a position slightly to left of the plane's center line.

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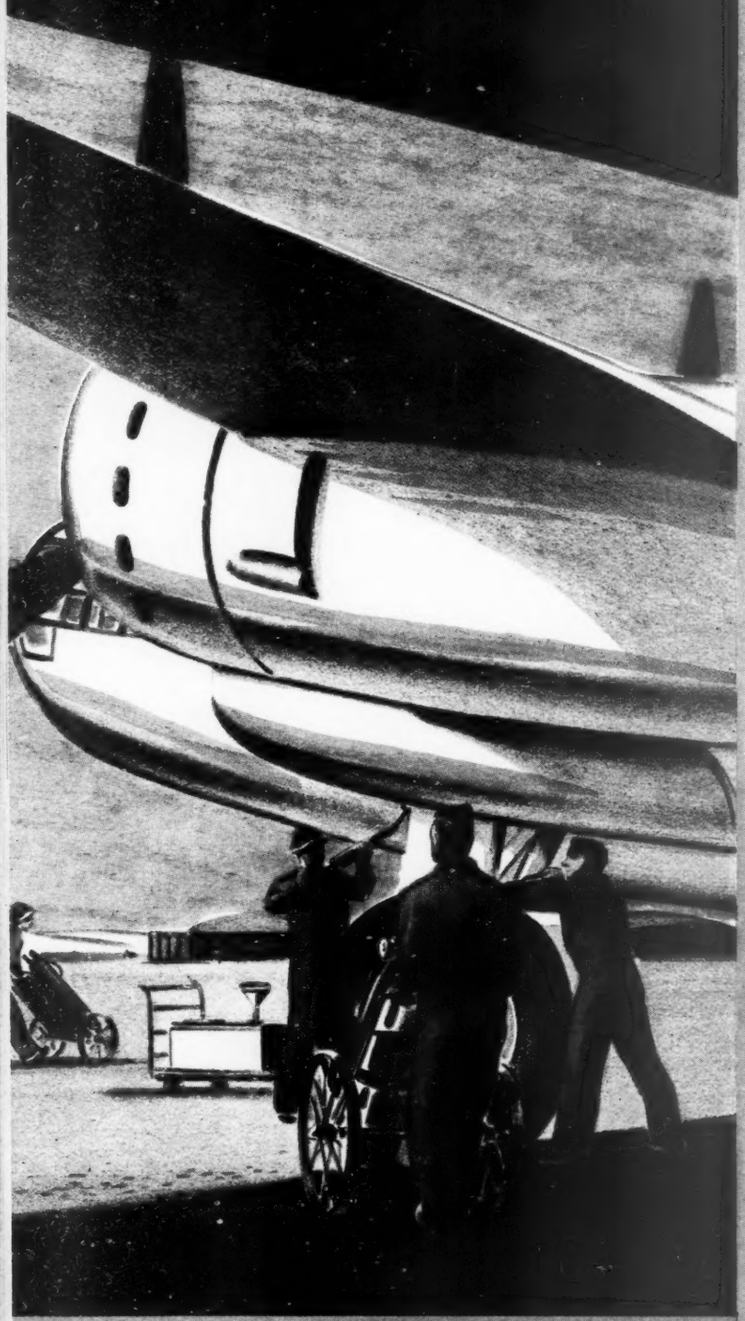

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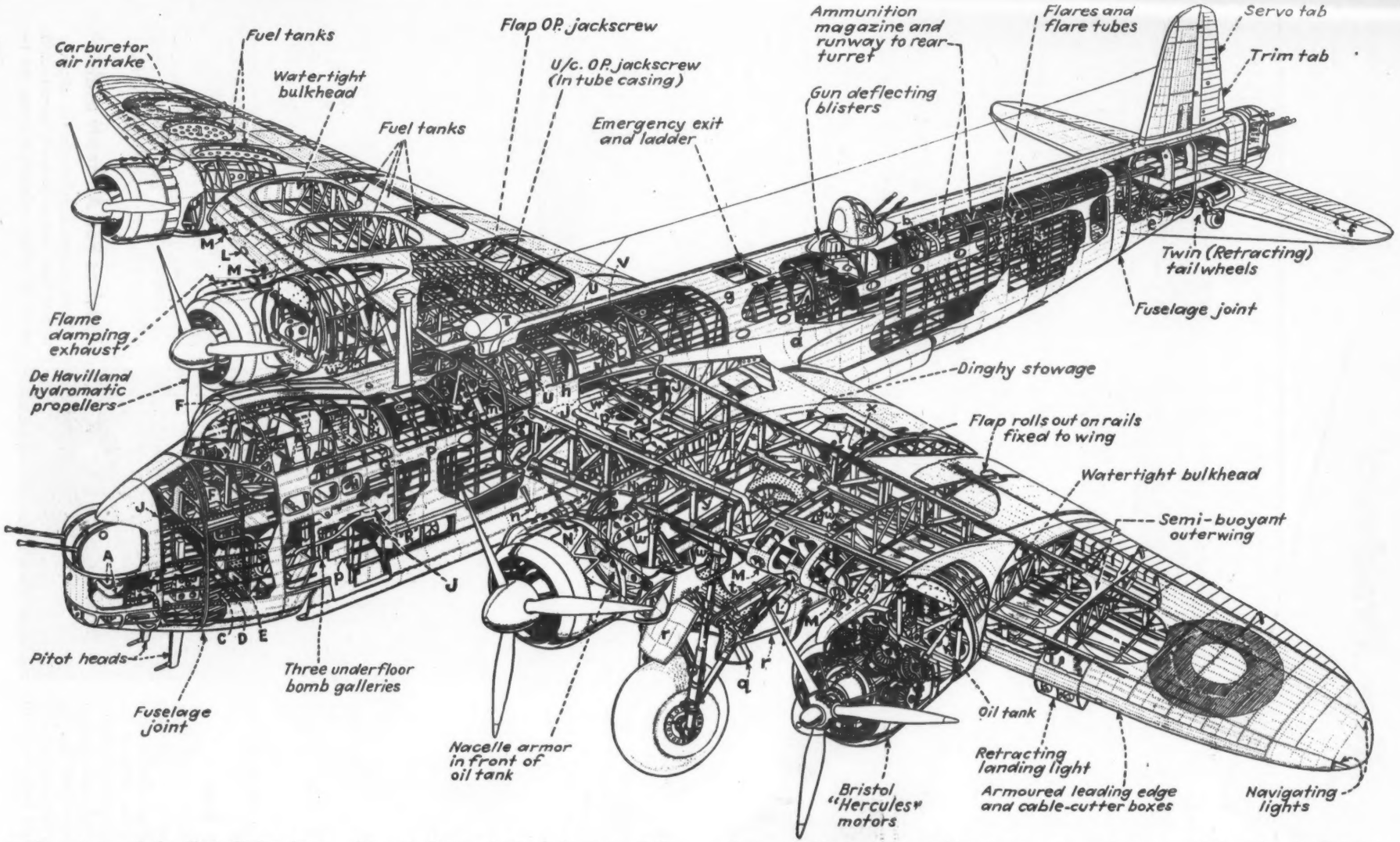
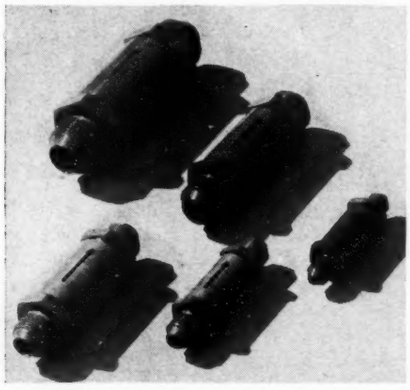



In the cutaway of the Short *Stirling* heavy bomber the following details are noted: A—Gunner's seat; B—Parachute stowage; C—Emergency hatch; D—Recognition lights; E—Stairway; F—Dual controls; G—Oxygen stowage; H—Navigator's chart table; J—Warm air conduit; K—Gallay steam air heater; L—Air inlet to Gallay heater; M—Oil cooler inlets; N—Steam circuit (exhaust to Gallay heater); P—Radio operator's compartment; Q—Fresh water tank; R—Water bottles; S—Astro hatch; T—D.F. loop; U—Oxygen bottles; V—De-icer fluid tank (for slinger rings); W—Fuel equalizer valve; X—Electric motor flap drive; Y—Worm for raising/lowering landing gear; Z—Trunnion support for worm (Y); a—Seats on ladder leading to midships turret; b—Flares; d—Elsan lavatory; e—Tail wheel retracting gear (electrical and hand); f—built-in mass balance; g—Sliding door (bulkhead for conserving cabin air); h—Engineer's compartment (also in front of spar); k—Armored bulkhead (pilot's compartment); m—Bunk; n—Trailing aerial fairlead; p—Bomb doors and operating mechanism; q—Mudguard; r—Landing gear doors; t—Landing gear tie beam and operating rods for doors; w—Beam built into wing to carry motor; y—Doors and racks of wing bomb cells, and, z—Fuel tank locating spigots. Armament consists of eight, .303 cal. machine guns. Interesting feature is the gun deflecting blister at dorsal turret. Courtesy *The Aeroplane*.

# New Products

## Bendix Check Valves

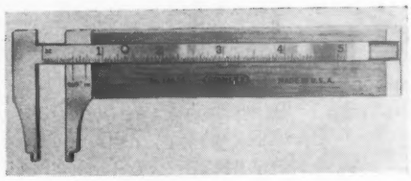
Featuring simplicity of design and adaptability to high production, a new line of hydraulic check valves is being widely installed on both Army and Navy military planes, following recent introduction of the new line of valves by **Bendix Aviation, Ltd.**, Burbank, Calif. Permitting hydraulic fluids to flow in



only one direction, while providing a positive seal against flow in the opposite direction, these valves have only four parts: body, plastic poppet, spring and connector. Use of the novel plastic poppet eliminates need of seat inserts, as the plastic valve seats directly in the aluminum alloy body. Weight is reduced because the weight of the poppet is only one-sixth that of a steel poppet. Extremely long life of the plastic poppet has been demonstrated by life tests of more than a half million cycles, and by service tests over a period of three years. Chattering is reduced and quiet operation assured through the lower inertia characteristic of the light plastic. Servicing is simplified as the poppet requires no pre-seating or lapping operation. The plastic poppet meets leakage requirements, even under low static heads, and will stand up under temperatures of 250 deg. F.—AVIATION, *May*, 1942.

## Stanley Caliper Rule

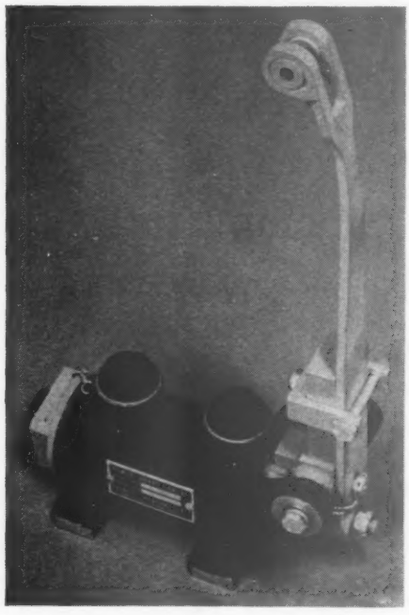
A new handy pocket size Caliper Rule for mechanics, engineers, draftsmen, etc., is made by **Stanley Tools**, New Britain, Conn. It is a useful tool for measuring rods, tubing squares, cable, rope, bolts, and pipe. The rule can be used for accurate inside and outside measurements. Caliper capacity permits measuring hole diameters from $\frac{3}{32}$ in. to



5 in., and widths or lengths up to 5 in. Diameters of rounds up to 3 in. can also be measured. Rule is made of boxwood, with brass caliper slide graduated by 16ths and 32nds its full length of 5 in. Head is carefully machined; back of rule has vertical graduations in 16ths for easy measuring—up or down, right or left on straight surfaces.—AVIATION, *May*, 1942.

## Power Brake Valve

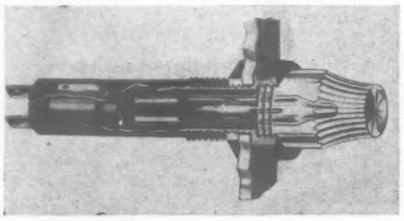
A new design of Power Brake Valve incorporating an external adjustable leaf spring lever has been introduced by **Bendix Aviation, Ltd.**, North Hollywood, Calif. Designated as Model 2250-B2, the hydraulic pressure at the brake port in this valve is directly proportional to the mechanical force exerted on the brake lever. This gives sensitivity and "feel" to the brake pedal. Valve also provides a pressure warning feature as the brake pedal will depress with no load when there is no pressure in the supply system. The spring lever is



quickly adjustable for brake pressure and pedal travel. Also readily accessible is an adjusting screw for governing rate of flow through the exhaust port by which the brake release may be controlled. Packing friction in the valve is said to have been reduced to a negligible minimum which greatly contributes to its high efficiency. Complete with spring lever the unit weighs 2.4 lb. The valve can be supplied with an internal coil spring in place of the spring lever, if desired.—AVIATION, *May*, 1942.

## Circuit-Break Reporter

A light that goes on only when the circuit is broken, is a time, trouble, and money saving service rendered to remote control by an indicator manufactured by **Littelfuse, Inc.**, 4757 Ravenswood Ave., Chicago, Ill. It is listed as Littelfuse Panel Mounting, N. 1414. When installed at any convenient or desirable point in connection with remote motor control it works instantly, with a plainly visible signal to show "on" or "off." When the circuit breaker opens, the



light goes on. It can be had for 24 or 48 v. filament bulb, with which no resistor is used. Otherwise it uses a built-in 200,000 ohm protective resistor, in series with a neon lamp. The resistor prevents the lamp from blowing out, as ordinary lamps do, on unexpected high voltages. In the Littelfuse installation the lamp glows on currents as low as 100 microamperes. The Littelfuse indicator has a black bakelite body, and transparent molded cap. It is made for panels up to $5\frac{7}{16}$ in. thick and $\frac{1}{2}$ in. diameter mounting hole. Overall length 2 in. below panel, $\frac{7}{8}$ in. above panel. The rating is 90 to 250 v. Regularly furnished without lamp.—AVIATION, *May*, 1942.

## Plastics For Aircraft Dials

Transparent acrylic plastic, already widely used for enclosures, turrets and noses of military planes, is being put to

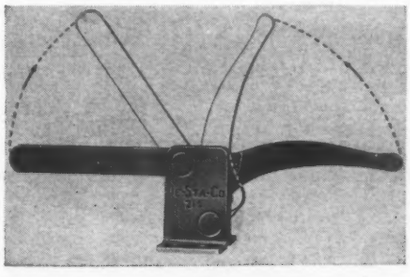
## New Products

another use, that of gage and instrument windows. Gages made by the **Boston Auto Gauge Co.**, 70 West St., Pittsfield, Mass., use Crystalite gage windows which are said to be actually clearer than plate glass and less than half as heavy. Molded in pairs, complete with mounting holes and ready for in-

stallation, they have the advantage of being virtually unbreakable. Toughness of the plastic also reduces breakage due to careless tightening of the bezel screws. The windows are molded by General Electric Co.—AVIATION, May, 1942.

## Light Duty Toggle Clamp

New light duty horizontal style toggle clamp has been added to the De-Sta-Co line of clamps made by the **Detroit Stamping Co.**, 350 Midland Ave., Detroit, Mich. The new clamp has a pressure ratio of 50 to 1. When in "shut" position (as illustrated), both handle and clamping bar are in a hori-



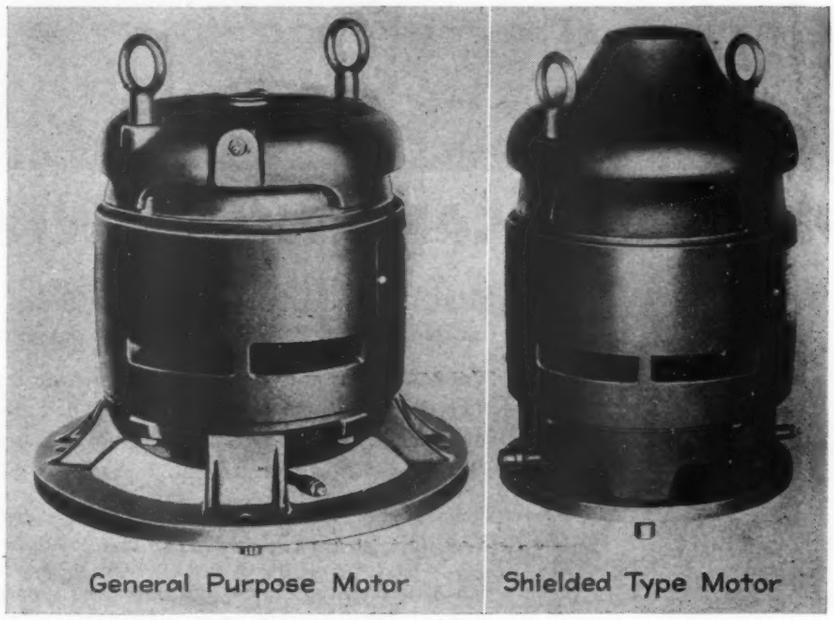
zontal position, thus reducing height. Measurements are 8$\frac{11}{16}$ in. across, 2$\frac{7}{16}$ in. high overall, and 1$\frac{3}{8}$x2$\frac{7}{16}$ in at the base. Illustration indicates movement of handle and clamping bar when clamp is being released to "open" position. Weight 8$\frac{1}{2}$ oz.—AVIATION, *May*, 1942.

## Whiting RA Unit

Simplicity and a high degree of accessibility in building up radial engine accessory sections are claimed by the **Whiting Corp.**, Harvey, Ill., for their new Type "RA" Unit. The new apparatus has a ring which clamps around the rocker boxes—at maximum diameter of the engine. Heavy rubber cushioning pads provide full protection to rocker boxes. In order to permit easy accessibility to any part of accessory section, entire assembly can be rotated 100 deg. in either direction, and interchangeable rings are available to handle various sizes and makes of engines. Adjustable propeller shaft support is equipped with bronze bearing free to rotate in bearing housing, which enables crankshaft to rotate periodically without interfering with assembly operation.—AVIATION, *May*, 1942.

## G-E Tri-Clad Motors

Three new motors—a vertical general purpose polyphase motor, a vertical shielded polyphase motor (1-20 hp.), and a vertical shielded single-phase motor (1-5 hp.)—have been added to the G-E Tri-Clad family made by **General Electric Co.**, Schenectady, N. Y. The compact, cast-iron frame and cover of the general purpose motors are designed to give added protection to electrical parts, without adding materially to overall height. Use of Formex wire, new punchings and coil shapes, double-end ventilation, and balanced design are features contributing to longer life. All openings in general purpose type are shielded to bar entrance of chips or falling objects. Accessibility of grease fittings allows rapid lubrication without dissembly of the motor; location of eyebolts makes it easy to handle; speed measurements are taken by removing the monogram cap from upper end of shield. The polyphase shielded type is available either in solid-shaft or hollow-shaft construction, while single-phase shielded motors are available only in solid-shaft construction. Both are for normal-thrust or high-thrust applications. Cover is contoured to deflect dripping liquids and falling objects. Openings in stator frame and end shields are protected against splashing liquids. Motors are suitable for outdoor operation except where extremes of moisture, dust, or other harmful agents make selection of fan-cooled motors more economical.—AVIATION, *May*, 1942.



General Purpose Motor

Shielded Type Motor

## Correction

In the April issue of AVIATION it was stated that the Timber-Lock Skid Platform was built by Redfield-Johnstone-McNevin, 142 Chestnut St., Philadelphia, Pa. This was in error. The Timber-Lock Skid Platform, which is of tough oak with only the legs made of metal, is built by the Philadelphia Division of the Yale & Towne Mfg. Co., Philadelphia, Pa. It is available in all standard sizes, and, being made mostly of wood, should be an appropriate type of platform in view of the priorities on steel.

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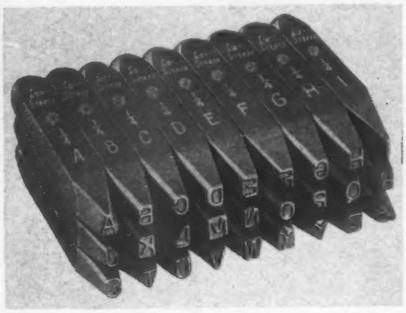
## "Lo-Stress" Steel Stamps

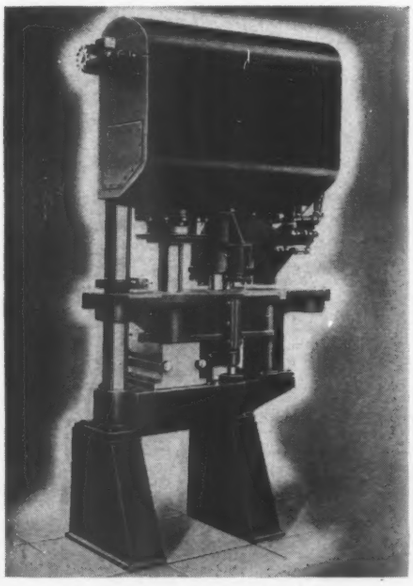
For safe face marking of aircraft, tubular or heat-treated parts, **Jas. H. Matthews & Co.**, 3942 Forbes St., Philadelphia, Pa., offer their "Lo-Stress" Steel Stamps. These round face characters are designed for marking parts placed in torsional or tensile stress and



where internal stresses of heat-treated steel may break out at point of marking on surface. The rounded impression and special character design of Lo-Stress stamps are said to provide the minimum stress set up by permanent marking. They are available in letter and figure stamps, hand stamps, stamping and roller dies, and in steel type for use in type holders.—AVIATION, *May*, 1942.

## New Extrusion Press

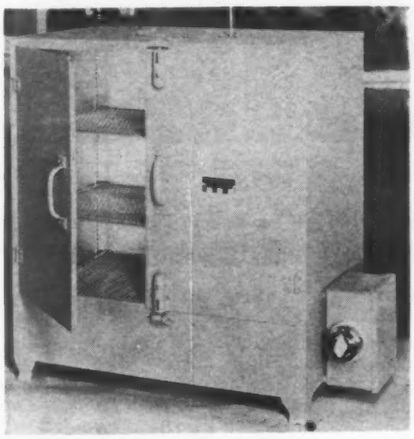
An improved 125-ton extrusion press which permits simultaneous loading and extrusion has been developed by **The Watson-Stillman Co.**, Roselle, N. J. The first of these units will extrude carbon mixtures but the press is also suitable for extruding any plastic material. The press has two containers, mounted on a swinging arm. Operator starts the automatic extrusion cycle by push-button



control, then devotes undivided attention to loading the free container. Container arm is provided with lifting cylinders for easy swinging and with hold-down cylinders to seal container against die during extrusion. Main ram is 12½ in. in diameter and has a 12 in. stroke. Advance speed is 54 in. per min., pressing speed is 6.4 in. per min. at 2000 lb./sq. in., and return speed is 150 in. per min. Power is from two Vickers pumps driven by a 5 hp. motor. Complete unit is 10 ft. high and requires 4x3 ft. floor space.—AVIATION, *May*, 1942.

## Small Despatch Ovens

Many important manufacturers of aircraft, aircraft engines, aircraft instruments, and other miscellaneous products, it is said, have found that the standard line of small Despatch ovens made by

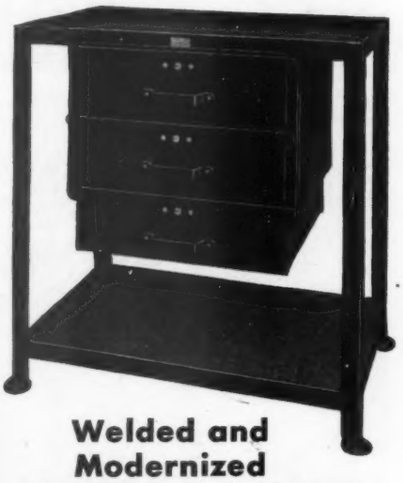


the **Despatch Oven Co.**, Minneapolis, Minnesota, fits their needs perfectly for various heating and drying operations up to 400 deg. F. These small ovens are especially desirable for the drying and baking of finishes on wall precision instruments or for the drying and hardening of radium painted numerals on instrument dials. The units are also ideal as drying and baking ovens to dry glyptol-dipped coils of various descriptions. It is reported also that these ovens serve as heat control cabinets to store parts and subassemblies to prevent rust and corrosion. This standard line of Despatch ovens provides three standard stock sizes—the smallest being 14x14x18 in.; the second 14x14x24 in. and the third, 18x24x30 in.—AVIATION, *May*, 1942.


TREAT 'EM ROUGH!

1869 Penco Steel

TOOL STANDS and CABINETS



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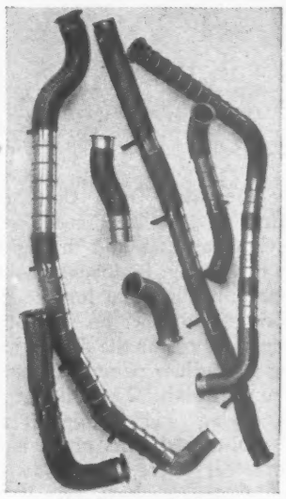
Rex-Flex Stainless Steel Flexible Tubing is available in five wall-forms, all of which can be combined in a single one-piece length, with straight walls and corrugated sections at desired intervals. Sizes 5/16" I.D. to 5" I.D. incl. Made of 18-8 (Austenitic) Stainless Steel. Fittings are attached to tube ends by circular resistance welding.

**No Flux, No Flame, No Quenching—Producing Absolutely Tight, Homogeneous Assemblies**



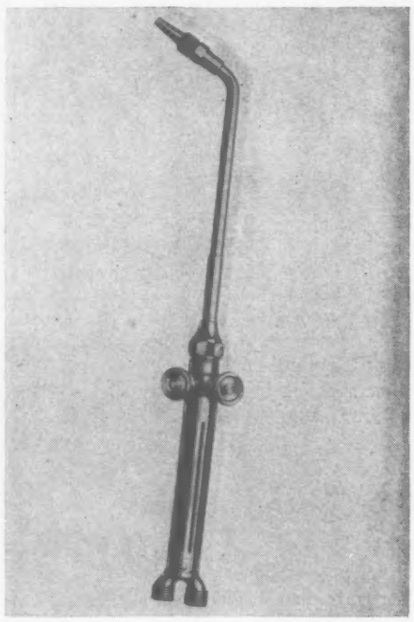
Units Shown are Typical Vari-formed Assemblies.

**CHICAGO METAL HOSE CORPORATION**
**MAYWOOD, ILLINOIS**
***Factories: Maywood and Elgin, Illinois***


## New Products

### Weldit Torch

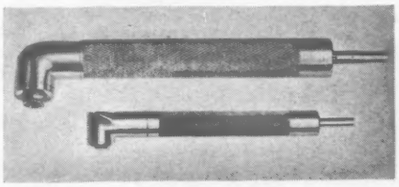
A new welding torch, measuring but 13 in. long and weighing less than ¾ lb., has just been announced by **Weldit Acetylene Co.**, Detroit, Mich. This torch



has replaceable tip nut and the maker claims it to be especially suitable for sheet metal and aircraft welding work.—AVIATION, *May*, 1942.

### Aircraft Angle Drills

New angle drills, recently introduced by **Aircraft Tools, Inc.**, Los Angeles, Calif., have pre-loaded ball bearings that are said to insure smooth, quiet operation, and long tool life. Standard direct



drive angle drills are available in 45 deg. drill for close operations. Flexible shaft angle drills have a 30 in. shaft of high grade steel core with rubber-covered casing. When used with Aerocraft drill adapters for holding small drills, these angle drills serve a wide range of functions in manufacturing plants and maintenance shops.—AVIATION, *May*, 1942.

**This is a "doer's" battle . . .** this building of a mighty nation's giant air fleet. Bottlenecks must be eliminated. This requires vast quantities of timesaving equipment behind the machines, behind the men speeding aircraft production. Modern motors, control, welding, and "speeding-up" equipment of all kinds must be made available in record time.

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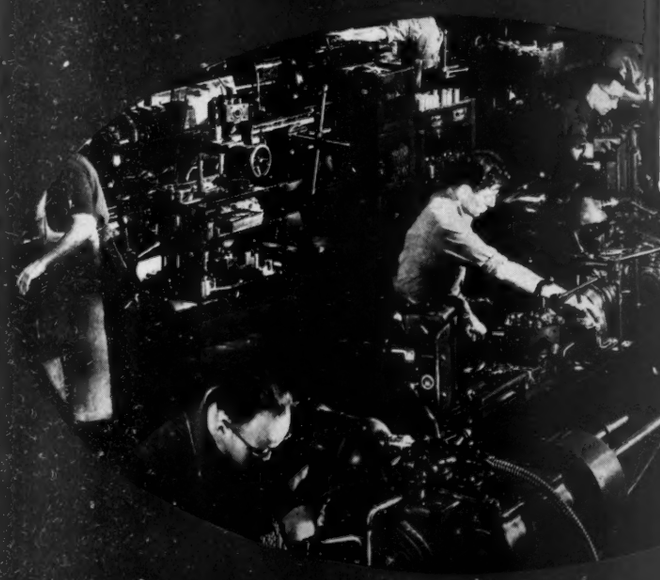
SAVES TIME—A Westinghouse development, the Pacesetter electric furnace saves vital time . . . clean-loaded stainless steel parts without decarburizing, oxidation and warpage, which require extra operations in ordinary heat-treating. See how you can eliminate these extra operations in your production . . . write Westinghouse today for the Pacesetter folder, B-4505.

...ON THE ASSEMBLY LINE



...AT THE AIRFIELD

## It's this help in the groundwork that leads to air supremacy

There are two outstanding reasons why Westinghouse is especially able to help you with your individual aircraft problems . . . to help you "keep 'em flying."

**FIRST:** Westinghouse has the manufacturing facilities . . . greatly expanded capacity . . . and a thorough system of factory testing to assure peak performance on the job.

**SECOND:** Westinghouse has the engineering facilities. Westinghouse engineers have been working closely with the aviation industry since its inception. They know many of your special problems in plants, on assembly lines and at the airfield. Furthermore, they have the research and design facilities to work them out. The dynamometer for testing of aircraft engines, resistance welding, control pulleys made of a tough, lightweight material, special lighting to speed airport traffic . . . these are only a few outstanding examples of Westinghouse engineers' ability to solve highly specialized aircraft problems.

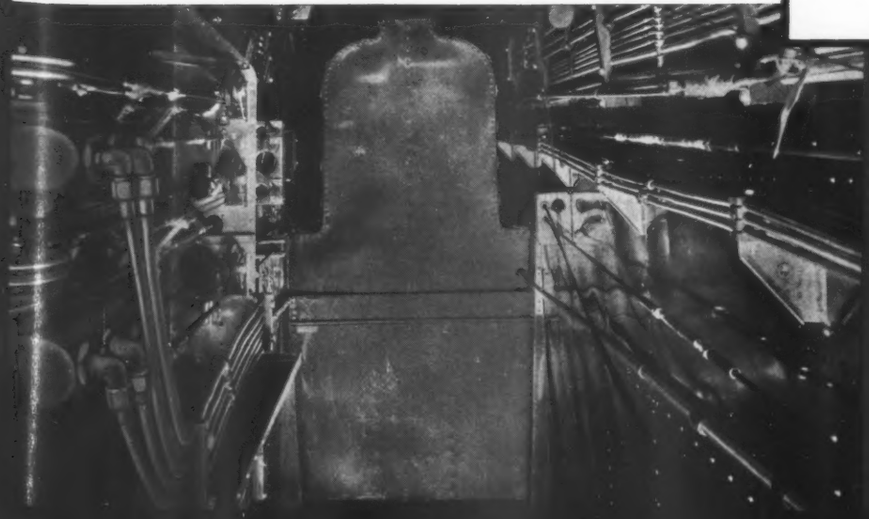
Our entire experience and resources are at your service for any aviation problem. A call to our nearest Westinghouse office will bring you our immediate and full co-operation.

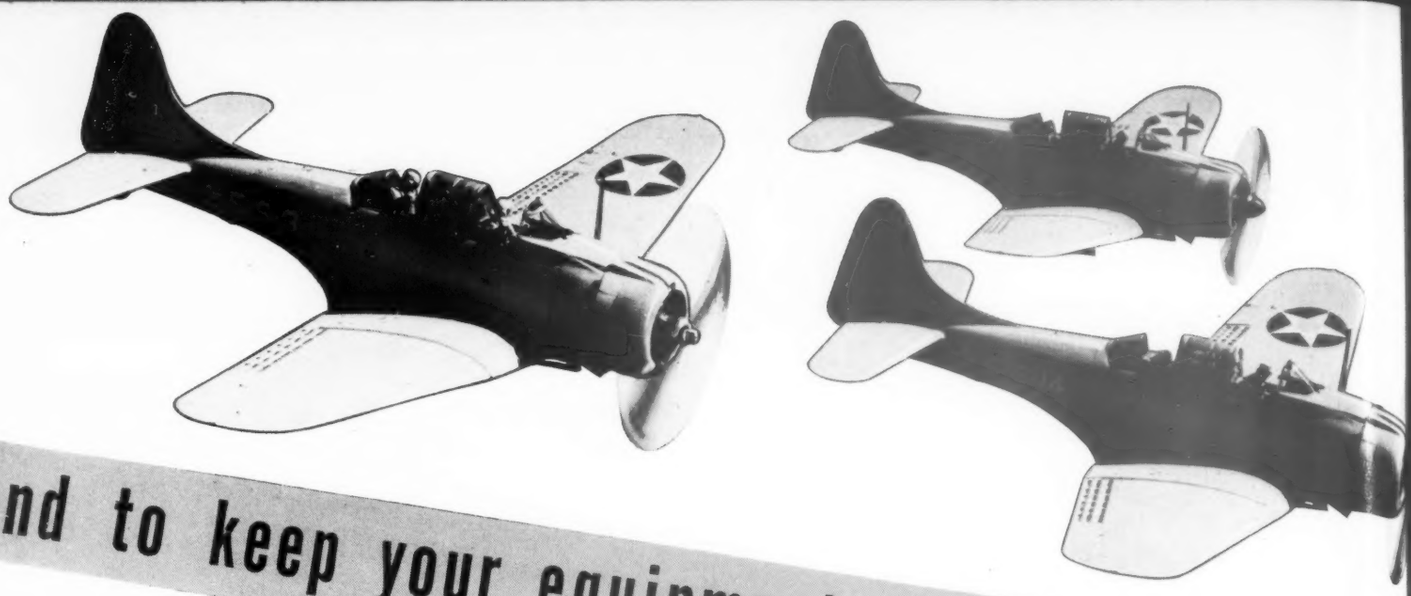
★ SPEEDS TRAFFIC—In close co-operation with C.A.A., Westinghouse has standardized a complete line of approved lighting and distribution equipment for all airports. The flashing red cross, at the top of the page, and the control desk, just above, highlight two traffic control features of the Westinghouse installation at one of the largest airports in the country. For easy-to-use authoritative help in airport lighting, write for the new book "Lighting and Distribution Equipment, C.A.A. Approved," B-3046, complete with large work sheets.

...IN THE PLANE ITSELF

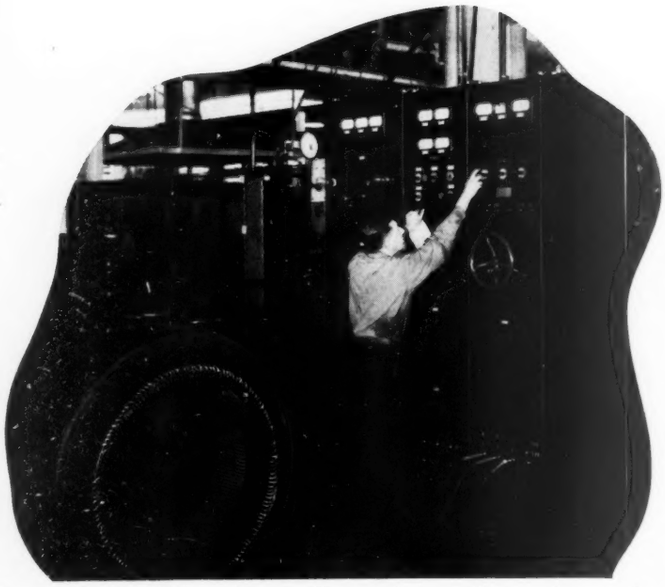
★ INSTRUMENT ACCURACY—Westinghouse electrical indicating instruments for aircraft (see above) and for assembly plants have been developed for quick, easy reading and accuracy. Standardization of aircraft instrument mounting tube centers assures full accordance with government specifications. Write for illustrated booklet, B-3078.

★ SAVES WEIGHT—Hundreds of thousands of Westinghouse Micarta control pulley wheels are being used in modern aircraft, because they are lightweight and have a very low coefficient of friction. Because of their weight and strength, Westinghouse Micarta is used in over 25 places in modern aircraft, including fair-leads, bushings and bearings. Write for B-3077.





# and to keep your equipment operating . . .



## 4 WESTINGHOUSE SERVICES

★ **FIRST:** To speed renewal parts to you, Westinghouse has established 17 warehouses in or near leading aviation centers. Stocks on hand include those parts normally subjected to the most wear or burning such as contact tips, shunts, coils and bearings. When your own emergency stock of renewal parts runs low, order direct from our local office.

★ **SECOND:** To facilitate major repair work, Westinghouse has established 34 district manufacturing and repair plants. Each of these plants is equipped to repair, remodel or recondition electrical apparatus. More than 4,000 employes are now serving our customers from these district plants alone. Call our local office to save time on repair service.

★ **THIRD:** To help you with the problem of getting more out of your present equipment or in consideration of a change to save time and speed production, Westinghouse maintains a staff of experienced engineers at every Westinghouse office. These men are constantly working with plant and aviation engineers in every phase of the industry. Many of the problems thus solved may provide a quick answer to a similar problem of yours. Use this service the next time a problem arises.

★ **FOURTH:** Westinghouse has prepared a valuable book "Maintenance Hints" which gives you helpful suggestions on the care of electrical equipment . . . including ways to make it last longer and give you better service. "Maintenance Hints" is free. See that each of your maintenance men gets a copy. Just fill in the attached coupon and mail it today.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

## TO *Keep 'em flying*

**WRITE TODAY FOR FREE COPIES**

Westinghouse Electric & Mfg. Co.,
East Pittsburgh, Pa.

Please send Maintenance Hints to:

Name .....

Company .....

Address .....

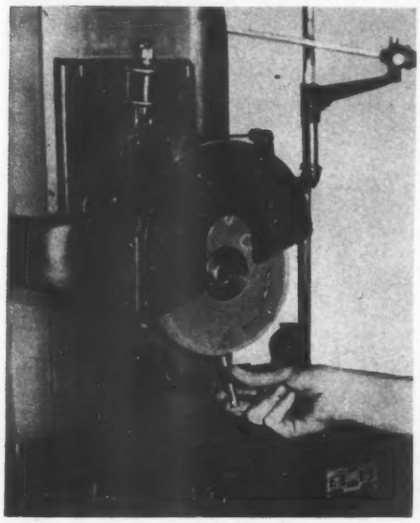
J-94488

# Westinghouse

***TIME-SAVER FOR THE AVIATION INDUSTRY***

## Scherr Radius Dresser

To speed up and simplify the dressing of grinding wheels for various types of grinding work, the **George Scherr Co.**, 128 Lafayette St., New York, N. Y., has designed the "Little Wonder" Radius Dresser. Device is used in conjunction with a diamond tool to dress wheels preparatory to grinding forming tools, fillets, end mills, for grinding rake angles on collapsible tap chasers. It will dress



either convex or concave radii from zero to 1 in., and can be set with regular 1 in. micrometer, depth micrometer or height gage, company says. Base is made of cast iron especially alloyed, rough machined and normalized before finishing, to prevent changing. Swinging arm is of cast iron and heat-treated before finishing, and centers are turned at both point and sides, hardened and lapped true.—AVIATION, *May*, 1942.

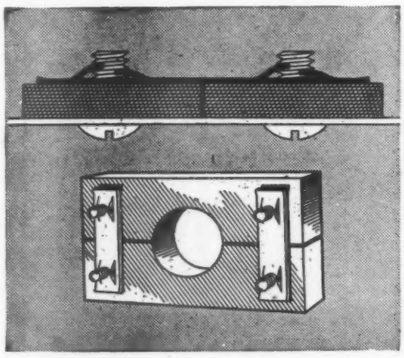
## Automatic Multiple Riveter

An automatic Multiple Riveter, Model G-3000, is the newest addition to the line of riveters manufactured by the **General Engineering Co.**, 785 Hertel Ave., Buffalo, N. Y. This riveter is fully automatic in operation and is designed for

high speed riveting on large, difficult to handle assemblies, such as bomber wing spars and skins, cabin floors and bomb doors. Handling is reduced to its simplest form by merely rolling the part through machine by means of longitudinal motorized feed rolls. Transverse positioning is eliminated by use of movable riveting units aligned automatically and motorized for automatic or push button positioning. A novel feature automatically permits riveting to be done at various levels without work moving up or down. Uniformity of rivet head height is controlled automatically regardless of variations in combined stock thickness. All controls operate from one portable panel. Machine control may be changed from full automatic operation to manual push button positioning and pedal (or push button) riveting by throwing a single toggle switch. Each of the two riveting units is capable of heading six $\frac{1}{4}$ in. diameter, nine $\frac{3}{16}$ in. diameter, or fifteen $\frac{5}{32}$ in. diameter aluminum alloy rivets.—AVIATION, *May*, 1942.

## "Twin-Type" Speed Nuts

A new series of "Twin-Type" Speed Nuts which eliminate washers and use of wrenches, save weight, cost, and many



handling operations in the attachment of split fairlead guide blocks, is announced by **Tinnerman Products, Inc.**, 2038-46 Fulton Rd., Cleveland, Ohio. The new Speed Nuts are also said to be ideally suited for many other attachments throughout the airplane where fasteners are grouped in pairs. Twin Speed Nuts are available for center-to-center spacings between screws of $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1 in. —for either AN 515-6 and -8 or AC 530-6 and -8 screws—and are made either with or without hole in center for riveting.—AVIATION, *May*, 1942.


**CRESCENT**
**is an important source of supply for**
**AVIATION CABLE**

Crescent manufactures a complete line of electric wire and cable for every aircraft need—starter cable, high-tension cable, primary cable—original or replacement. Crescent also manufactures welding cable.

And every Crescent Aviation Cable is a quality cable—made of prime materials, processed under the Dostam Method of manufacture for high efficiency, long life, dependability and uniformity.

We will promptly answer your inquiries concerning wire or cable for any type of service.

**THE CRESCENT COMPANY**
**Pawtucket • Rhode Island**
*Largest independent maker of replacement wiring for the automotive industry*

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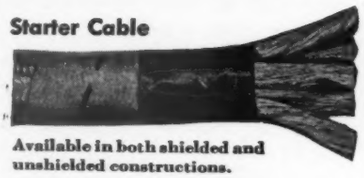
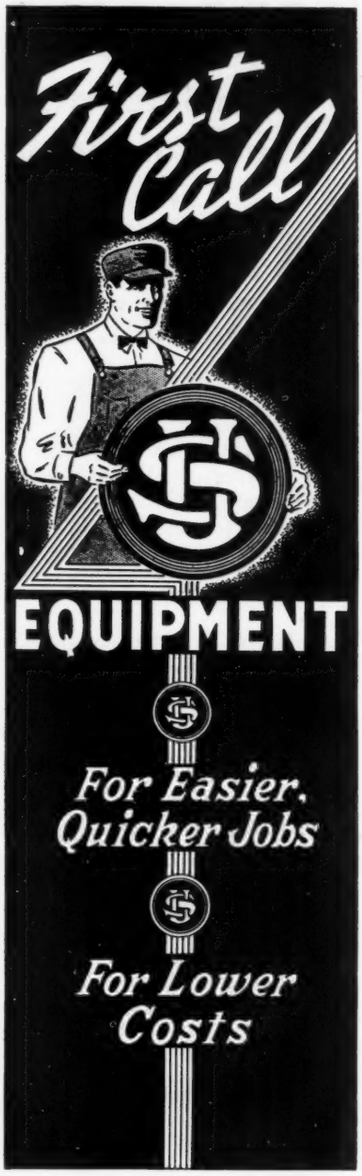


**Available in both shielded and unshielded constructions.**

*P.S.*
OF COURSE, CRESCENT WIRE AND CABLE FOR THE AIRCRAFT INDUSTRY MEETS ALL ARMY AND NAVY SPECIFICATIONS . . .
Wiry Joe




A MITE IN SIZE
But
MIGHTY
in efficiency

Model 14ARD ¼" Heavy Duty Aircraft Special Drill
*ball-bearing*

United States Electrical DRILL
for the AVIATION INDUSTRY

GETS PLACES when production must go places . . . easy to reach those ordinarily "hard to reach" points.

Universal motor, 750 to 5,000 rpm; ball-bearings in steel retainers easily removed; switch adaptable for right or left handed workers; streamlined construction . . . no protruding surfaces end to end; close-coupled; air-cooled. Easily accessible for inspection, replacement or adjustment.

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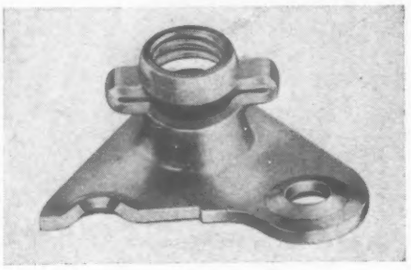
THE UNITED STATES ELECTRICAL TOOL CO.
CINCINNATI, OHIO, U.S.A.

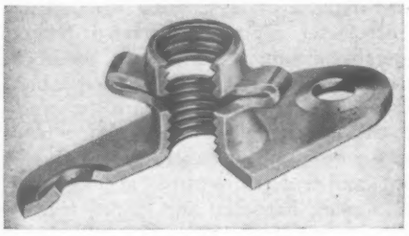

## New Products

### Dimpled Rivets

To help speed production and save time, the **Boots Aircraft Nut Corp.**, New Canaan, Conn., states that machine dimpled rivet holes are now available on its entire self-locking anchor nut line. Many companies want flush rivet mount-



ings, and this extra service will help aircraft factories eliminate the time-wasting need of machine countersinking in their own shops. This augments the



present line of plain base rivet holes by the addition of dimpled rivet holes for use with 78 deg. and 100 deg. countersunk rivets. Parts with rivet holes so specified are identified by adding suffixes to the standard part number.—AVIATION, *May*, 1942.

### Quikcet Speed Clamp

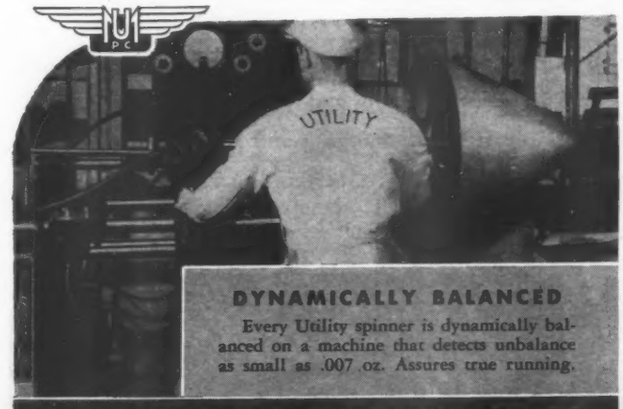
A fulcrum leverage speed clamp called Quikcet, just put on the market by the **Grand Specialties Co.**, Chicago, Ill., provides four second clamping and one hand operation, it is claimed, through setting with ratchet rod instead of turn screw. According to manufacturer, there can be no slipping of work, even on beveled surfaces. Side screw tightening permits clamping in close quarters and also quick release. Rod and screw are copper plated and "V" shoes may be furnished for pipe and rod holding.—AVIATION, *May*, 1942.

Utility Spinner on Lockheed P-38

# UTILITY Spinners

Made to exacting specifications in Utility's complete plant facilities

Utility Builds ammunition chutes, cabin air heaters, floors, doors and other components




**DYNAMICALLY BALANCED**

Every Utility spinner is dynamically balanced on a machine that detects unbalance as small as .007 oz. Assures true running.

**UTILITY METAL PRODUCTS CO.**

4851 S. Alameda St., Los Angeles, Calif.



# GENERAL CONTROLS HIGH PRESSURE HYDRAULIC VALVES

LIGHTEST WEIGHT

FASTEST OPERATION

MOST COMPACT

LEAST CURRENT

2-WIRE CONTROL

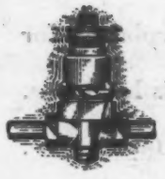
PACKLESS DESIGN

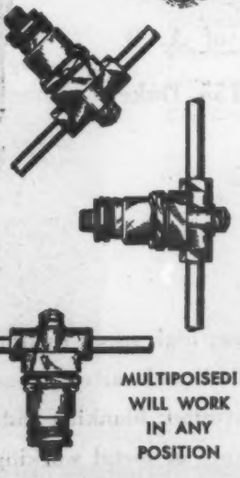
D.C. OPERATION

*General Controls Type AV-3 Electric Valve, normally closed type.*

## POSITIVE CONTROL OF HYDRAULIC AND ANTI-ICING FLUIDS, OIL, GASOLINE, AIR OR OTHER GASES

WILL STAND VIBRATION





MULTIPOISED! WILL WORK IN ANY POSITION

These two-wire, compact, electric valves are designed specifically to obtain positive operation regardless of mounting position, vibration, or acceleration, i.e., substantial increases in "g". Furnished in normally open and normally closed types for pressures from zero to 1500 lbs. or more. Continuous duty or intermittent duty or other electrical variations are available. Extremely fast operation, even to less than 1/100th of a second is practicable.

**NEW BULLETIN** describes complete General Controls AV Series which includes valves for engine priming, gasoline cross feed, oil dilution and fuel control to heaters; also high pressure 3-way and 4-way selector valves. Write for your copy.

*Write for Specifications and Valves for Inspection and Test*

# GENERAL CONTROLS

*PIONEERS AND LEADERS IN THE DEVELOPMENT AND MANUFACTURE OF MAGNETIC VALVES*

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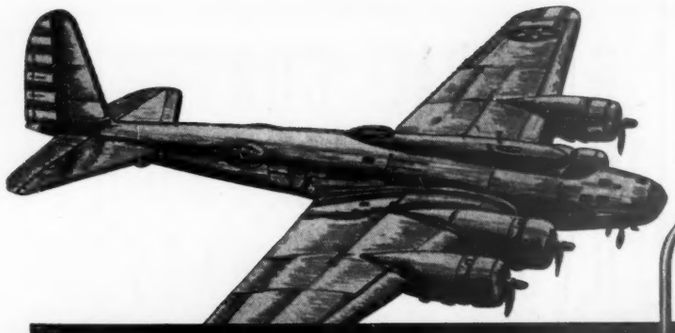


## to put more planes in the air

THIS new Farquhar hydraulic press for forming airplane parts is ready to do its share to fill the air with powerful warplanes for America. Total capacity is 1500 tons. Rubber pad measures 60″ x 36″. Hydraulic Press Division of A. B. Farquhar Co., Limited, 155 Duke St., York, Pennsylvania.

**Farquhar is supplying high speed hydraulic presses for: smokeless powder; blocking, graining and finishing; shell and cartridge case piercing and drawing; gun and shaft straightening; forging and extrusion; blanking and forming of aircraft parts; flanging and forming for shipbuilding; all types of metal working. All types, sizes, capacities . . . from 3 to 7200 tons.**

# FARQUHAR Hydraulic Presses

## New Products

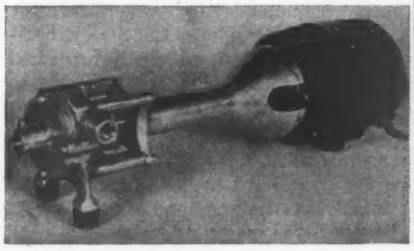
### "No Blink" Starter

The G-E "No Blink" Starter, made by **General Electric Co.**, 1285 Boston Ave., Bridgeport, Conn., for 40-w. lamps is designed to eliminate entirely the blinking and flickering of fluorescent lamps that have reached the end of use-

ful life. At the same time, starter life is said to be greatly prolonged because the starter does not wear itself out in repeated attempts to start the dead lamp. Two exclusive features distinguish the G-E No Blink Starter: (1) The user gets automatic and quick restarting after momentary or longer-line power interruptions, and, (2) when relamping fixtures, the starter lights the new lamp instantaneously.—AVIATION, *May*, 1942.

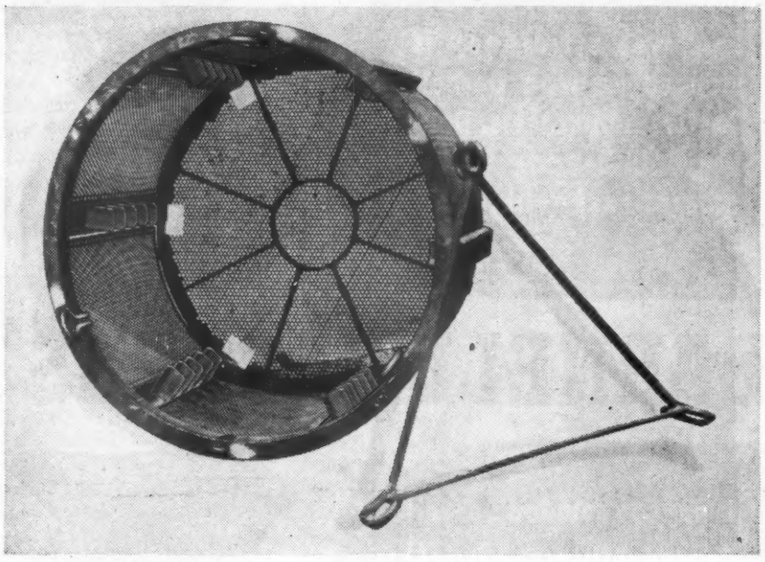
### New Hot Liquid Pump

A newly designed and engineered Midget Hot Liquid Pump is announced by **Eastern Engineering Co.**, 45 Fox St., New Haven, Conn. Called Model EH, the pump can be used in industrial, pilot plant, laboratory and experimental ap-

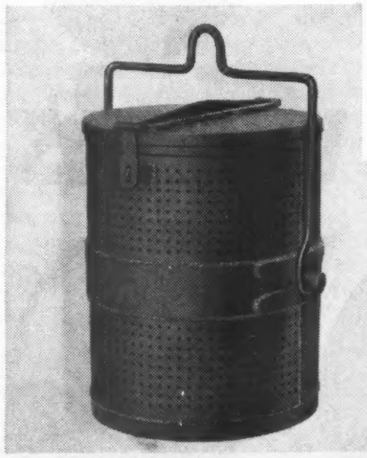



**Pressed Steel Company**

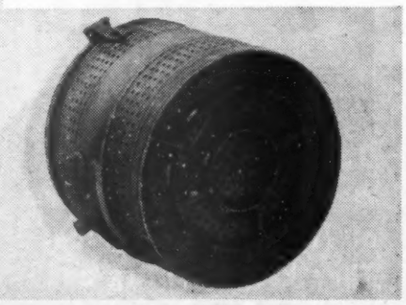
**PRODUCTS FOR THE AIRCRAFT INDUSTRY**



Annealing and Quenching Basket for Aluminum and Maganese castings. Supplied in various types and sizes and furnished to your exact specifications.



Pickling Basket made of type 304 stainless steel. It is 3 ft. in diameter and 5 ft. high. Special bottom construction to specifications.



**THE PRESSED STEEL COMPANY**
of WILKES-BARRE, PENNSYLVANIA

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**PRESSED STEEL COMPANY PRODUCTS:** Carburizing and Annealing Boxes, Thermocouple Protection Tubes, Seamless Steel Cylinder Caps, Seamless Steel Neck Rings, Welded Alloy Tubing for High Temperature and Corrosive Application

**Speed** WITH RELIABILITY

IS NEEDED TO MEET PRESENT URGENT PRODUCTION DEMANDS

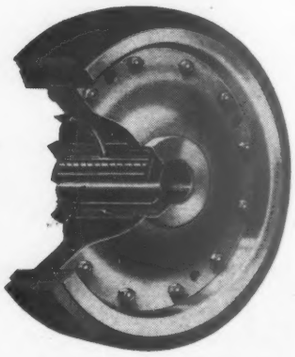
Employee efficiency is stepped up with Darnell Casters and Wheels. Double Ball Bearing Swivel assures easy rolling.

**DARNELL CASTERS**

It pays to demand Darnell Dependability. Darnell Products reduce the overhead that is underfoot by reducing floor wear to a minimum.

**E-Z ROLL WHEELS**

Darnell Products are made to give a lifetime of Trouble-free service. They keep turning and earning. Buy Darnells!



**DARNELL CORP., LTD.,** LONG BEACH, CALIF.

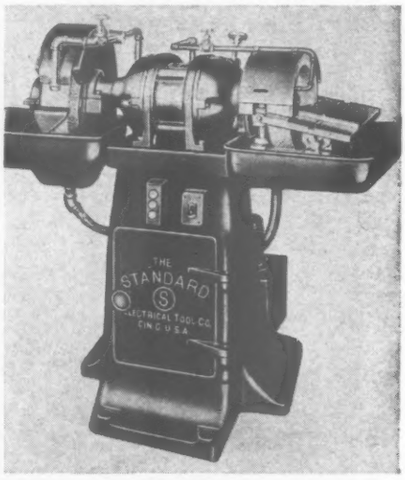
36 N. CLINTON, CHICAGO • 60 WALKER ST., NEW YORK


## New Products

plications where thin liquids at temperatures up to 500 deg. F. are to be handled. Compact in size and construction, it is the centrifugal type, size 12x4x4½ in., and weighs 7 lb. Motor is 1/20 hp. Universal Fan Cooled for use on 115 v., a.c. or d.c. Maximum pressure is 21 psi. and maximum volume 7½ gpm. Pumps are made in stainless steel, monel metal, chromium plated bronze, Hastelloy "C", and other alloys. Units can usually be delivered in one week from stock.—AVIATION, *May*, 1942.

### New Carbide Tool Grinder

Designed to meet today's exacting requirements for speed and efficiency, a new Carbide Tool Grinder, Type CCGA, has been built by the **Standard Electric Tool Co.**, Cincinnati, Ohio. Machine is equipped with a 3 hp. 1,150 rpm. motor for use with an 18 in. diameter by 2½ in. face straight grinding wheel. Suitable flanges are furnished to accommodate




this size wheel with 10 in. diameter hole. The outside diameter of the wheel flange is 15 in. so that actual wheel waste is but a 1½ in. thick ring. On opposite side, the spindle is furnished with a steel plate to accommodate mechanically mounted 14 in. diameter cylindrical wheels for face or finish grinding. On the cylindrical or cup wheel side there is furnished a table which is not only adjustable to angle with suitable graduations, but may also be adjusted to compensate for wheel wear and raised or lowered to permit grinding various size tools. Advantage of the combination machine is that the 18 in. wheel operates at a speed

efficient for reducing time required in the roughing operation and when completed, the tool is then taken to the cup wheel side of machine for finishing. Motor is reversible through reversing magnetic starter and separate 3-button push button station. The machine may be used for grinding dry, or with the wet grinding attachment.—AVIATION, *May*, 1942.

## Hammond Dust Collectors

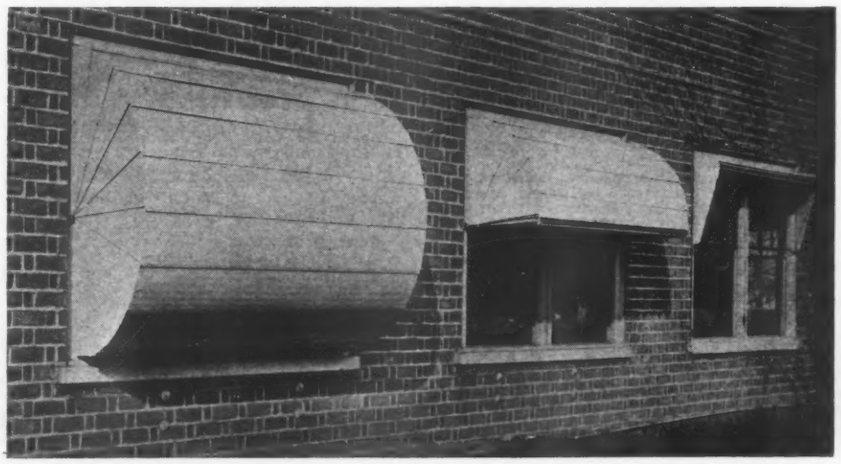
A new line of self-contained Dust Collectors Units in three sizes have just been announced by **Hammond Machinery Builders, Inc.**, 1638 Douglas Ave., Kalamazoo, Mich. Known as Models 30, 40 and 50, they are of a new, compact,

functional design, requiring a minimum of floor space. Filtering capacities range from 275 cu. ft. per min. to 1,100 cfm. with air velocities in inlet ducts up to 6,000 cfm. There are two standard inlets in each unit, 3 in. in diameter on Model 30, 4 in. in diameter on Model 40, and 5 in. in diameter on Model 50. Inlets in special locations and of special sizes, other than standard sizes furnished, can be supplied on all models if desired. Motor capacity is ¼ hp. on Model 30; ½ hp., Model 40; 1 hp., Model 50. Filters, three in each unit through which the air passes, are the "throw away" type made of glass fibre, and are easily removed for cleaning or replacement through an ample opening in the back of the unit. These units have a multitude of applications with various types of grinders in plants which do not have central exhaust systems, and in plants whose central exhaust system is not available to numerous isolated grinders.—AVIATION, *May*, 1942.

## New Products

## Meta-Fold Blackout Awning

A new practical answer to the blackout problem for industrial, commercial and residential buildings is seen in the introduction of the "Meta-Fold", metal blackout awnings, designed and manufactured by the **Acklin Stamping Company**, Toledo, Ohio. These sturdily constructed metal awnings are installed on the exterior of the building and operated as simply as the old-time roll top desk. For sunlight protection, the metal awning can be lowered halfway. For complete blackout, the awning is fully lowered. To conserve space when the awning is raised, it has been designed in segments of "galvannealed" steel that nest together in a telescopic manner. Each segment is sealed from the other by a light-proof, noise-absorbent gasket. Entire awning is rustproof and fireproof, and can be provided with an inside lock. Among other advantages claimed are elimination of telltale reflection from the moon and other outside light at night; permanence of installation which requires no seasonal taking down and storing; full use of daytime light.—AVIATION, *May*, 1942.

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hands

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***Stock shim materials obtainable from your mill supply distributors. (Write us for sample and illustrated application chart.)***

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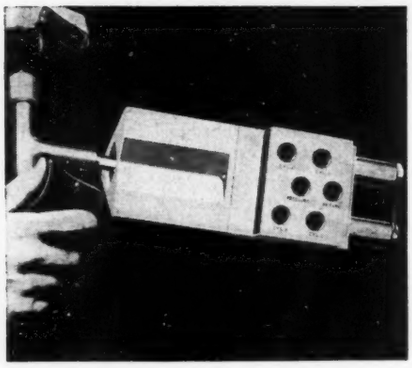
**Incorporated**
**80 Union Street** **Glenbrook, Conn.**

*it's*
**LAMINUM**
THE SOLID SHIM THAT *peels* FOR ADJUSTMENT

## Fleetwings Gun-Turret Valve

Latest addition to the large line of hydraulic equipment made by **Fleetwings, Inc.**, Bristol, Pa., is a new valve, Model B2J, which provides a means of operating a gun turret, at a variable speed, in order to enable the gunner to maintain a continued fire on a moving target. The valve is both light in weight and easy to operate. Only one valve is required per turret, as it incorporates two units, one for the lateral movement of the gun and the other for elevation control. Combined weight of the units, however, including operating mechanism, less grips, is under five pounds. The B2J valve will operate without seizure from below minus 40 to over 200 deg F., it is said, and being fully balanced, it requires a minimum force, three to four pounds to operate over and above the force used in overcoming the centering spring. Particular care has been taken to assure easy disassembly and assembly without damage to packing rings or other parts.—AVIATION, *May*, 1942.



## New Blackout Bulb Unit

Important changes in blackout bulb specifications are announced by the **Wabash Appliance Corp.**, 335 Carroll St., Brooklyn, N. Y., whose silver-lined blackout bulb placed on the market in early January was put through exhaustive blackout tests in actual city-wide black-outs in practically every state. Specification changes are based on the results of these tests, as well as on various official recommendations. Most important specification change is in color of light from blue and red to the deep orange recommended by the Office of Civilian Defense. Other changes are in size, which is smaller, in reduced current consumption to 15 w., in elimination of the former built-in reflector, and in the improved type of heavy black silicate coating to prevent light leakage. Bulb will fit any household socket. New unit shown at right in photo.—AVIATION, *May*, 1942.

# New Products

# WINDOW SHOPPING

**Cherry Rivet**—A one-man blind rivet, which in the hollow type can be applied it is claimed, at the rate of more than 1,200 per hr. without use of bucking bar. Descriptive pamphlet includes blueprints of both hollow and self-plugging brazier head blind rivet assemblies. Cherry Rivet Co., 1819 Barranca St., Los Angeles, Calif.

**Plomb Streamlined Tools**—Catalog of the Plomb line for all industries. Plomb Tool Co., 2209 Santa Fe Ave., Los Angeles, Calif.

**Doehler Die Castings**—How die castings save strategic metal machines and manpower. Doehler Die Casting Co., 886 Fourth Ave., New York, N. Y.

**Wiremold Catalog**—New additions to the Wiremold line to meet needs of electrical contractors and electrical industry. The Wiremold Co., Hartford, Conn.

**Refrigerated Welding**—The "Frostrode" process of referigerated welding described in new 4-page bulletin. Frostrode Div. of Weltronic Corp., E. Outer Drive, Detroit, Mich.

**DuPont Plastics**—Bulletin 14, giving news of new developments in the plastics field. Plastics Dept., E. I. DuPont de Nemours & Co., Inc., Arlington, N. J.

**Challenge**—New and complete catalog of precision equipment for tool and machine industries illustrates, describes and lists specifications on the Challenge line of lapping plates, layout surface plates, bench plates, work benches, etc. The Challenge Machinery Co., Grand Haven, Mich.

**Over 1000 Million Rings**—Illustrated story of a vast experience in piston ring manufacture. Muskegon Piston Ring Co., Muskegon, Mich.

**Industrial Rubber Service**—Prepared in vest-pocket size format, a series of six pamphlets on *How to Get the Most Service Out of Industrial Rubber Products* has just been published. A "must" for information on rubber conservation. B. F. Goodrich Co., Akron, Ohio.

**Looking in on Honest Weight**—New 16-page brochure providing pictorial survey of human and mechanical resources back of making the modern precision scale. Graph traces development of weighing devices from 5,000 B. C. to present. Toledo Scale Co., Toledo, Ohio.

**Tap Reconditioner**—How tap life and efficiency can be greatly increased by "Detroit" tap reconditioner described in 4-page folder. Detroit Tap & Tool Co., 8432 Butler St., Detroit, Mich.

**How Are Balls Made Round?**—Grandma knew, and you can, too, by reading this interesting pamphlet describing ten steps in production of Atlas balls. Atlas Ball Div., SKF Industries, Inc., Front St. & Erie Ave., Philadelphia, Pa.

**Rex Slo-Mixers**—Latest folder describing Rex sanitation equipment, with illustrations and technical information. Chain Bell Co., Sanitation Equipment Div., Milwaukee, Wis.

**Heim Roller Bearings**—Description, specifications, tolerances and load rating data on Heim self-contained roller bearings. Bulletin No. 16. The Heim Co., Fairfield, Conn.

**Educational Calendar**—Unique big 1942 calendar available free of charge to industry, schools and libraries. Contains 12 comprehensive lessons on metal working, other interesting data on production. Continental Machines, Inc., 1301 Washington Ave., South, Minneapolis, Minn.

**Revised Bronze Table**—*Table of Bronze Specifications to Government Requirements*, just issued. Lists all alloy grade numbers cast by Ampco to various governmental specifications. Ampco Metal, Inc., 1745 So. 38th St., Milwaukee, Wis.

**Shakeproof Products**—Catalog No. 42, covering full line of Shakeproof fasteners. Attention of subcontractors with Army or Navy orders is directed particularly to section on U. S. Government specifications and approvals for Shakeproof Products. Shakeproof Inc., 2501 Keeler Ave., Chicago, Ill.

**Anodizing Aluminum by Chromic Acid Process**—New booklet, together with a reprint of a more technical treatise, on the anodic treatment of aluminum is of special interest. Tables and charts supplied. Mutual Chemical Co. of America, 270 Madison Ave., New York, N. Y.

**Dilecto**—Catalog DO 41 issued to acquaint men in industry with the properties of Dilecto, a laminated phenolic plastic first produced in 1911. Continental-Diamond Fibre Co., Newark, Del.

**Engineering Chart**—Handy chart giving all essential data on over 122 sizes in 18 standard types of IRC fixed and variable resistors for war and industrial requirements. Contains up-to-minute information including wattage and voltage ratings, dimensions, maximum and minimum resistance values available, terminals, mountings, temperature rise, variations with time, tolerances, etc. International Resistance Co., 401 North Broad St., Philadelphia, Pa.

**Old Name in New Field**—Booklet describing automatic riveting machines for aircraft makers made by a company long manufacturers of rivets and riveting machines. Chicago Rivet & Machine Co., 1830 So. 54th Ave., Cicero P. O., Chicago, Ill.

**Westinghouse Electric Heating Units and Controls**—Recently revised 38-page catalog describing heating units and controls for industrial application involving heating of liquids, solids or air. Westnghouse Electric & Mfg. Co., Heating Section, Mansfield, Ohio.

**Speed Up Your Production**—Die List No. 18 of "Compo" oil-retaining porous bronze bearings, listing wide range of sizes in sleeve-type, and flanged bearings and thrust washers. Bound Brook Oil-less Bearing Co., Bound Brook, N. J.

**General Controls**—New 48-page catalog No. 51 of General Controls' complete line of regulatiors, control systems, and solenoid valves—just issued. General Controls Co., 801 Allen Ave., Glendale, Calif.

**Metal Shielded Wire**—Bulletin 201 containing complete mechanical and electrical specifications of approved aircraft wire manufactured to spec. No. AN-J-C48 and No. 95-27074 by Packard Electric Div., General Motors Corp. Shielded with thin wall, seamless copper, aluminum and lead tubing by Precision Tube Co., Philadelphia.

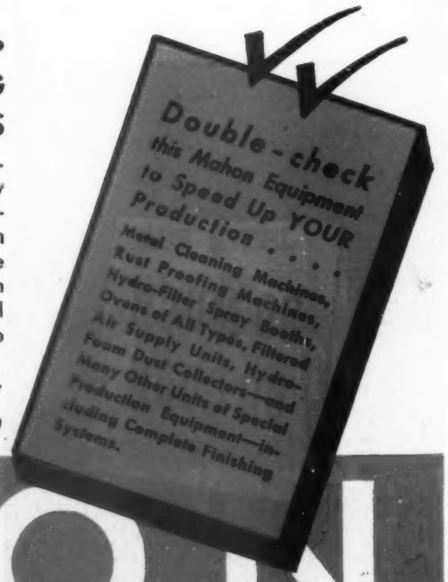
3-stage, Conveyor Type Washing Machine, specially designed, built and installed by Mahon engineers for cleaning airplane crankcases, cylinder blocks and pistons.

# *Designed and Engineered . . . .*

## TO PUT YOUR METAL CLEANING ON A WAR PRODUCTION BASIS

How to speed up the cleaning of metal parts—do a thorough cleaning job—and at the same time cut down man-hour costs—is a problem faced today by many manufacturers, who must keep war production rolling through. The built-to-the-job metal cleaning equipment, illustrated above, solved just such a problem for a large automobile manufacturer engaged in the production of airplane engine parts. If you have a similar problem, the extensive experience of Mahon engineers can be applied to advantage in bringing about a quick and economical solution in your metal cleaning operations. Put this specialized knowledge to work for you without further delay. There is no cost for consultation.

**THE R. C. MAHON COMPANY**
DETROIT • • CHICAGO




# MAHON

# NINE VOLUMES OF IMAGINEERING

***THESE NINE BOOKS*** are designed to help all men, everywhere, do the Imagineering that improves methods of production and speeds delivery to our fighting men of all war materiel made of aluminum.

***HERE AT ALCOA,*** Imagineering has enabled us to double production and to be well on the way to tripling it, in an amazingly short time. And still the expansion goes on. Swinging immense new plants into top volume at top speed;

building again, and manning that new capacity efficiently . . . This is Imagineering at work for the war.

***WE'RE BREAKING RECORDS*** by sheer determination backed by know-how.

***YOU'RE DOING THE SAME.*** Perhaps your men, many of them new to the ways of working with aluminum, can help you get even more speed through the know-how these books contain.

***IN THE DAYS*** when we made only a driblet of Alcoa Aluminum Alloys, compared to the great flood we are now pouring into the war effort, our engineers could counsel with you personally on fabricating procedures. Today many of these men have been brought back to our plants to join the drive for production. From these books you can get much of the know-how our men used to bring you personally.

***OUT OF THESE PAGES,*** too, will come the exciting Imagineering of the future. Many of the products you will create to meet the new competition, *as well as* millions of jobs for our boys as they come home, will stem from that Imagineering.

Aluminum Company of America, 2182 Gulf Building, Pittsburgh, Pennsylvania.

★ SO MUCH SO SOON ★

# ALCOA ALUMINUM

# Subcontractors Section

**On the editorial pages of this section AVIATION's staff will provide information on newest developments in government and industry concerning agencies and procedures designed to assist in "spreading the work." Also, descriptions of practical wrinkles, case histories and so on which have demonstrated their value in this endeavor.**

**To speed the process of subcontracting, AVIATION provides in this section a meeting place between prime contractor and subcontractor.**

**Here manufacturers desiring subcontract work may quickly bring their facilities to the attention of prime contractors who urgently need them.**

## Spreading the Work for Victory

### Subcontracting Gains Momentum Under Huge Production Drive

"AN IDEAL SUBCONTRACTOR, would be one who could take ideas out of the mind of the prime contractor's project engineer hundreds of miles away, set them down on paper, make production drawings, start the assembly line, and deliver the finished parts promptly—ready to go with the rest of the airplane as conceived by the project engineer." So says a discussion of engineering-liaison service in the *Fleetwings Arrow*, publication of Fleetwings, Inc., an organization which functions in the dual role of both prime and subcontractor.

It points out, however, that "pressure on the prime contractor for more and more subcontracting runs against the hard fact that while he can often secure additional shop capacity, he has no ready means of providing the supervision, engineering service, or inspection which is particularly essential in a plant which has contracted for work foreign to its normal peacetime job."

Nevertheless, heartening progress toward at least a reasonable facsimile of the ideal subcontractor is being made by small operators all over the country, many of whom thought only recently that it was impossible to "get some war work."

For example, a prime contractor furnished Fleetwing the contours, loads, and weight requirements for tail surfaces of a fighter plane. With this basic information, the surfaces were designed, production drawings were made, assembly line operation was started and the first surfaces were delivered within two months, with the result that American craft equipped with such surfaces are today in active combat against the Axis.

A complete engineering department is not essential, however, to successful subcontracting, it is maintained by both prime contractors and government officials who are charged with success of the 60,000 plane production program for this year.

Thousands of small shops throughout the country, it is pointed out, are capable of a "double-barreled job"—that of producing war materials and of providing work for sorely needed skilled and semi-skilled labor. When the potential subcontractor says, "I want to do some war work," his job is not ended, it is explained. Just as was the case in peacetime, he has to go out and sell his product or service. It is not so much a matter of "selling," though, as it is of letting the prime contractors know what he can do, how much he can do, and how fast he can do it.

That everything possible is being done to facilitate subcontracting is indicated by recent action of the Senate when it passed—by a vote of 81 to 0—and sent to the House a bill designed to establish the Smaller War Plant Corporation under the War Production Board, together with an appropriation of $100,000,000 to help finance small industries in war production.

In this connection the WPB is establishing a new regional office in New York City to coordinate contract distribution in New York and the northern part of New Jersey, the first of 13 such regional offices to be set up throughout the country.

Announcing the new offices, James H. Knowlson, director of the Division of Industry Operation, said that "our plan is to place as much authority as possible for War Production Board operations in these new regional offices. Other field offices now operating in 120 cities will be administered by the regional directors. This will lead to more effective coordination of the service provided to the public through these branches. All

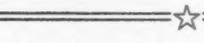
# *"I will"*

The following was found on the flyleaf of the diary of an Iowa boy who fell at Chateau-Thierry in 1918:

"America *must* win this war. Therefore *I will* work; *I will* save; *I will* sacrifice; *I will* endure; *I will* fight cheerfully and do my utmost, *as if the issue of the whole struggle depended on me alone.*"

**..."as if the issue of the whole struggle depended on me alone."**

THE BG CORPORATION • NEW YORK



# BITS and PIECES of SYNTHETIC RUBBERS

BUT these bits and pieces have a tough assignment. No stock compound can give them the physical characteristics they need in actual combat.

Some must resist high aromatic gasoline, some must remain flexible at —60° C, some must retain a high tensile in the presence of hot oil, and some must adhere firmly to steel, brass or aluminum. And when we make them, they do it.

Our pieces do as they should because our research staff knows how to build up a compound from the best synthetic for the job. In other words, it is custom made with no strings attached and no effort spared.

We are busy, of course, but if it will help win the war we will find a way to do it.

The Connecticut Hard Rubber Company — NEW HAVEN, CONN., U.S.A.

# YOU'LL GET *Action* HERE

Sales, Purchasing, Engineering, Development, Production, comprise the Lyon War Production Staff. Each has specific responsibilities taking precedence over any other company duty.

## *On your* SUB-CONTRACTS *for* FABRICATED METAL PARTS

● Lyon's war production staff—with more than a year's experience in expediting Prime Contracts and Sub-Contracts for fabricated sheet metal products—assures you quick and constructive action.

This staff—representing all major departments involved in the problem—meets every day. To make every minute count, our field men are specially trained to gather all pertinent facts to permit speedy planning action by the War Production Staff.

Back of this staff is one of the best equipped organizations in America for fabricating sheet metal. It operates big, modern plants covering an area of over half a million square feet. Completely equipped toolrooms assure prompt production and maintenance of all necessary dies and jigs.

So, if you have products or parts of products to make for Uncle Sam that require fabrication of No. 8 to No. 30 gauge sheet steel . . . let's go. Lyon has the facilities to make them for you in large quantities . . . they "know how" to produce them the way you want them and to have them ready when you need them. Write for "Craftsmen in National Defense."

**LYON METAL PRODUCTS, INCORPORATED**

*General Offices: 5805 Madison Avenue, Aurora, Illinois*

**Sales and District Offices Manned by Experienced Engineers in All Principal Cities**

**GET ALL THE FACTS:** This comprehensive brochure has been prepared to simplify the task of determining where Lyon facilities can be used to best advantage in accelerating armament production . . . A copy is yours for the asking.

**LYON METAL PRODUCTS, INCORPORATED**

of them are now offering advisory service on priorities and contract distribution, and their scope will be enlarged as the regional plan progresses."

### CONVERSION PROBLEM

The close tolerances required for aircraft production work has proved a stumbling block to securing subcontracts in many cases; it is said to have "scared away" many others who might have obtained war production work with little or no conversion of existing facilities.

Reporting on 30 case histories of automobile dealers obtaining or working on war contracts, Cyrus McCormick of the Office of Price Administration declared that "the fallacy that all war work requires precision tools and skilled labor has discouraged many dealers from the conversion idea, but the series shows that more simple, less mechanical operations, when surveyed and studied properly, can be performed by many automobile dealers." Among those reported on were contracts for plane subassemblies, plane assembly tables, rifle bolts, bronze shafts and other items.

In some cases the automobile dealers have pooled their resources through associations, such as Denver War Industries, Inc., made up of 16 dealers; and a group of 28 Kansas City dealers who, through an association, are working on a sizeable assembly contract.

Other subcontracting groups have greatly enhanced their production facilities through formation of trade associations such as those described by Jack Frost, executive secretary of the Aircraft Parts Manufacturing Association, in AVIATION for February, 1942.

Single-handed conversions continue also, as is shown by the American Central Manufacturing Corp., formerly the Auburn Central Manufacturing Corp. "The company's Connersville plant is working three shifts a day on war orders, including aircraft wings for dive bombers, other aviation parts, reconnaissance car bodies for Army 'jeeps', and kitchen cabinets and sinks for defense housing projects," according to Saunders P. Jones, president.

"Our normal business has been so curtailed that it has been supplemented by war production. We still have some unequipped space available and negotiations are in progress with the government and prime contractors doing government work with a view to its utilization in turning out further war materials."

At the same time the company reported net earnings for the quarter ended Feb. 28 of $217,929, after all charges, including federal taxes of $326,894, compared with a loss of $145,059 in the same period a year ago.

**Subcontractors Section**

## Lyon Company Book Tells How to Tackle War Business

*How One Company Tackles the War Production Problem* is a booklet which should prove helpful to all businesses faced with problems of conversion to defense work or subcontracting.

This is an actual case history of how one American manufacturing concern, faced with the loss of more than half of its business, planned and executed that plan to obtain prime contracts and subcontracts, in order to keep the business going.

The manufacturer involved in this case study was prevailed upon by manufacturing friends to publish this story as a guide which would be helpful to other manufacturers.

The book is a step-by-step treatment of how this company set about to regain lost production—replacing former peacetime products with war products. Most interesting is the completeness of their campaign in going after subcontracts; the job within their own organization to coordinate all divisions of the business to expedite this work.

The fourth and final step in this book —"Coordinated Action," is packed with suggestions for every manufacturer, large or small. It deals particularly with the company's own War Production Board—a committee that meets every day to coordinate all divisions of the business on this one all-important problem of identifying the company with the war picture. The operation of this war committee is outlined in detail.

A copy of this book may be obtained at no charge by writing on your business stationery to Lyon Metal Products, Incorporated, 3017 Clark St., Aurora, Ill., and asking for the book *How One Company Tackles the War Production Problem.*

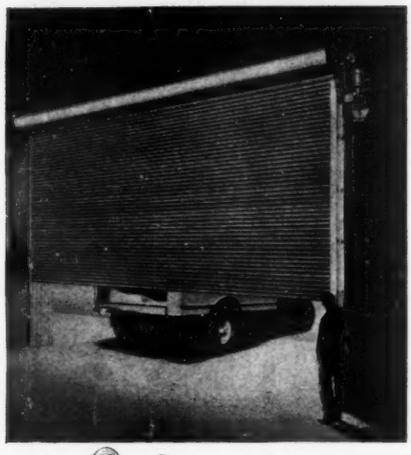
## War Orders Gather Speed

The tremendously accelerated pace at which orders for war supplies and equipment since the Japanese attack on Pearl Harbor was revealed last month by the War Production Board. Contracts and other commitments in February amounted to $20,892,000,000 compared with $8,414,000,000 in January, $5,132,000,000 in December and $1,782,000,000 in November.


LYON
Shop Equipment
For War Industries

● Results in plant after plant prove these Lyon Steel Shop Equipment items contribute to faster output. They reduce fire, sabotage and water hazards . . . save man and machine hours by preventing the misplacing and loss of tools and injury caused by splinters or nails. Write for catalog.

LYON SHOP EQUIPMENT Service



KINNEAR GIVES YOU "THE BIG THREE" IN WARTIME DOOR NEEDS

**ALL STEEL PROTECTION**

Kinnear's tough, interlocking steel slat construction prevents theft or intrusion, resists accidental damage, defies fire, wind and weather—and even closes light-tight for blackout safety!

**SAVINGS IN SPACE!**

All Floor, wall and ceiling space around each opening remains clear and usable at all times when Kinnear Rolling Doors are installed. Another score for Kinnear's famous coiling upward action!

**MOTORIZED EFFICIENCY!**

Extra savings in time and labor are gained when Kinnear Rolling Doors are equipped for smooth, rapid, dependable motor operation. And this permits the further advantage of *remote control*, with convenient pushbutton stations placed at any number of convenient points.

Full-speed, day-and-night war production brings the long-known advantages of Kinnear Steel Rolling Doors into sharper focus than ever before. Their capacity for years of hard, uninterrupted use under the most gruelling conditions has been proved over nearly half a century. Built any size, to fit any type of opening. Write today for new, complete data book! THE KINNEAR MFG. CO., 1440-60 Fields Ave., Columbus, Ohio.

*Saving Ways in Doorways*
KINNEAR
ROLLING DOORS


## Subcontractors Section

Commitments embrace contracts, letters of intent and other obligations incurred by the U. S. Government for war purposes, including expenditures for the armed forces during the month. Between June, 1940, and the end of February, 1942, such commitments reached a total of $81,835,000,000.

### Attention Prime Contractors

MAJESTIC METAL SPECIALTIES, INC., New York, announces formation of a new division, Majestic Aircraft, "prime contractors to the U. S. Navy, capable of manufacturing floats of any type; wing panels; fuselages; tail surfaces; catapult floats; hulls; and all parts of machine and die work" . . . **Utility Fan Corp.**, of Los Angeles, has added two new drop hammers of one and three ton capacity, as well as new spot welders, riveters, foundry equipment, power shears and ten presses ranging up to 375 tons capacity which will enable them to handle increased production of aircraft sheet metal and machine parts.

. . . **H. C. Evans & Co.**, 1520 West Adams St., Chicago, manufacturers of amusement machines, offer their metal and woodworking shop facilities to aviation prime contractors.

With 60,0000 sq. ft. of floor space, their machine shop equipment includes, lathes, shapers, milling and screw machines, punch presses from 16 to 50 tons; also a fully equipped tool room for making dies. Woodworking tools include standard machines adaptable to precision work.

The company states they are well equipped to produce electrical assemblies.

A good proportion of skilled workers are included in this organization, and almost all the company's capacity is available for war work.

### Attention Subcontractors

A New Jersey propeller manufacturer is seeking propeller parts in quantities of 400 per month. One item needed is a propellor base which requires the following operations; internal gear cutting, broaching, drill presses, profile milling, lathes, cadmium plating and heat treating.

Drawings and specifications and sample available at Display Desk, Contract Distribution Branch, WPB, 122 E. 42nd St., New York, N. Y.


SKILL and EXPERIENCE

***In the design and production of Plywood and Wood parts—***

**Here, at Manchester, N. H.,** is a compact and able organization, equipped to produce plywood and wood aircraft parts to your blueprints and specifications—

**Capable Management** with many years of design and engineering experience, expert woodworkers, are at your service—

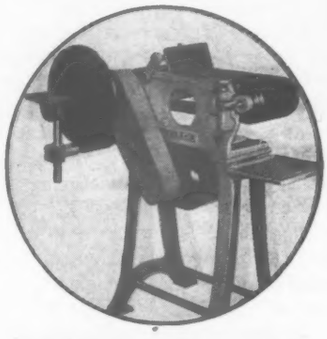
In recent months our engineers have intensively studied aircraft wood and plywood requirements, and have already produced ailerons on an experimental basis.

**Our Facilities** now include — 70 skilled employees . . . 18,000 sq. ft. of production area . . . Modern woodworking machines of all types.

*We are ready and able to serve you—*
WIRE OR WRITE TODAY

HERMSDORF
FIXTURE MFG. COMPANY
MANCHESTER, N. H.
*Plywood and Wood Parts*

*New!*



DUPLEX-B-M
Combination
Band and Disc Grinder

Improved and streamlined—heavily built for increased production and lower finishing costs.

Motor Driven Ballbearing throughout—Fully enclosed adjustable drive. Large disc grinding table.

Write for illustrated folder for this and other size grinders.

WALLS SALES CORP.
95 WARREN ST. • NEW YORK, N. Y.

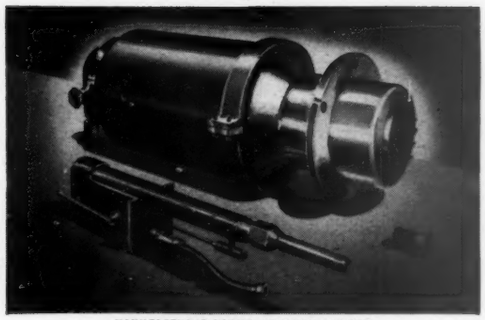
# *They ask No Odds...*

ON all fronts, often against overwhelming odds, the fighting qualities of the Curtiss Hawk have become legend. Now, in the most recent addition to this notable P-40 Series, past performance records are surpassed for the formidable task ahead.

CURTISS *Electric*
PROPELLERS

# Trigger-Quick Starting under all Conditions . . .

## *Instant Action at the Touch of a Switch*



MANUFACTURED UNDER COFFMAN PATENTS

BREEZE MARK

Radio Ignition and Auxiliary Shielding • Multiple Circuit Electrical Connectors • Flexible Shielding Conduit and Fittings • Conduit Junction Boxes.

Cartridge Engine Starters • Dichromate Cartridge Containers • Internal Tie Rods • Propeller Pitch Controls • Elevator and Rudder Tab Controls.

Flexible Shaft and Case Assemblies • Aeroflex Jr. Flexible Instrument Lines.

Tachometer, Fuel Pump and Remote Control Drives • Ammunition Rounds Counters • Radio Tuning Units.

Generator and Ignition Filters • Exhaust Gas Analyzers (Fuel-Air Ratio Indicators) • Flexible Metal Tubing • Resistance Type Thermometers • Swaging Machines and Tools • Armor Plate.

Stainless Steel Division: Pioneers in the design and development of stainless steel structures and fabricated products.

### *The* BREEZE Cartridge Engine Starter

• Powerful squadrons of American fighting planes roar into action daily in defense of Democracy. Quick starting, essential to wartime operation, is provided by the Breeze Cartridge Engine Starter. The touch of a switch in the cockpit sets off the starter charge, slow-burning fuel eliminates shock to engine parts and supplies a steady torque to the power plant of the airplane. Manufactured today for application to engines from 300 to 2000 HP, the Breeze Cartridge Starter is getting America's warplanes into the blue.

Breeze
CORPORATIONS INC.
NEWARK, NEW JERSEY

By ROBERT OSBORN

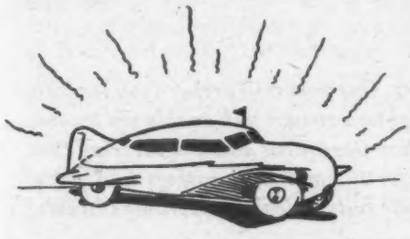
# SIDE SLIPS

» WHY DOESN'T SOMEBODY *DO* SOMETHING! All this brazen talk about the automobile industry taking over the flying machine business—and you airplane men just take it! Well, *Side Slips* is not taking it. Not lying down. Starting now, on our policy is that the *airplane* industry should take over the *automobile* industry. We call it the Side Slip to Cars Movement.

Just look at the automobile ads. They tell about a clipper style of car. They say their cars are like the new planes. They have airfoil lights. Somebody or other has a B-40 something. Another one has the feel of flying. And they have airplane engineering. You would think a car was just an airplane with its wings cut off.

Well, maybe it is! That's what started us thinking. Maybe the ad writers have got something there. If the folks will buy cars made by the auto boys to look like planes, how they *would* go for cars made by the *airplane* boys to look like planes.

Step forward here, Mr. Larry Bell! Think of cheap aluminum after the war! An aluminum car with no paint to polish —shining like a jewel in the sun. A *big*



car, with half the weight, going lots farther on a gallon. Such a job would take any man's weekly pay check!

Think what you could do, Mr. Glenn Martin. Put in dual controls! What man wouldn't pay $500 extra for dual controls? He could tell his wife to shut up or drive. And make her take it or else. Come out with dual controls and all the traffic cops in America will go crazy and be locked up. Both drivers in any given car could tell the cop that the other one was driving. Or, they could say it was all a mistake; neither *one* was driving.

Look, Mr. Phil Johnson! Why struggle along with thousands of airplanes when you can make millions of automobiles. Put in ventilators for the passengers to twist! Put in safety belts to hold spooners in a clinch. Put reading lights by the seats.

And you out there, Mr. Douglas. Go in for cars. Put on wing stubbs as fenders. Put burp cartons under the seats for drunks. Set flag sockets in your cowling. Stick your hood out four feet farther than it is now, and give it a rakish up-tilt. Give them an exhaust with blue flame. Give them a magazine rack. Give them oxygen! Give them a galley with a stewardess in it. Give them a sleeper, and advertise, "Why go home?"

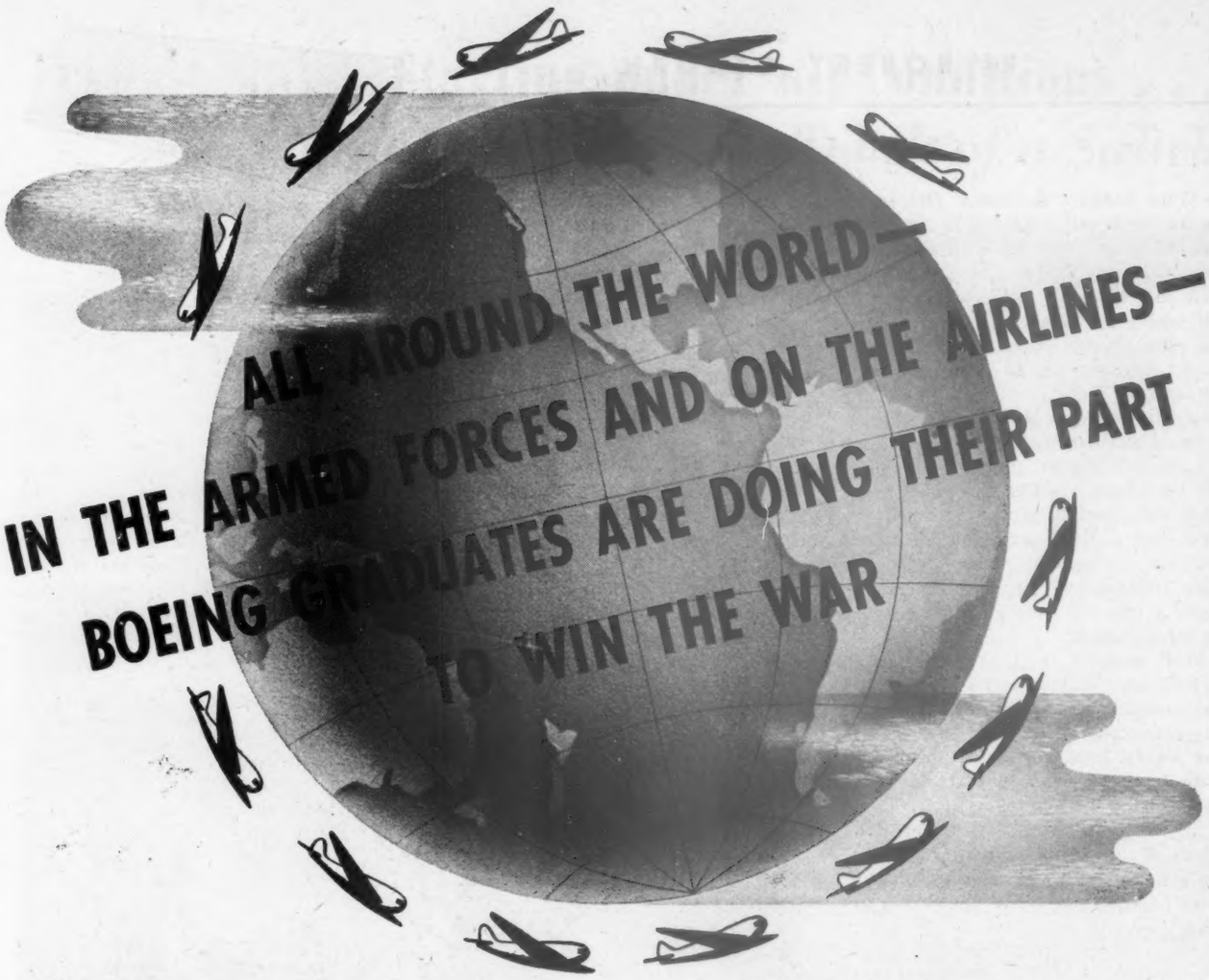
We got to joshing there for a minute, but this is serious. Think what your copy writers could do with something like an Autocobra, or a Strautoliner, or a Curtiss Drive Bomber.

The automobile men are getting low on ideas and are ready for the kill. For ten years they have been moving the ash trays around for sales points. Some time back they got knee action. They moved the shift handle. Now they've got several kinds of liquid drive, which is all to the good. But for their four or five good tricks in ten years, we can match them fifty in two years. Our outline above is just a sample.

Of course Side Slips is for air-cooled car engines. We've crossexamined a lot of engineers on this point, and we can spot you A-1-a opinion that water cooling is just a habit. They tell us that not enough work was ever done on air-cooled auto engines. And even if it had

(*Turn to page 248*)

*"Looks Like Old Man Maguire Is All Wound Up for a Spring Offensive!"*

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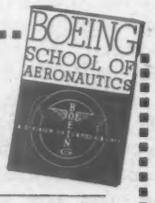


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**BOEING SCHOOL OF AERONAUTICS** UNITED AIR LINES A DIVISION OF UNITED AIR LINES

By W. W. MACDONALD

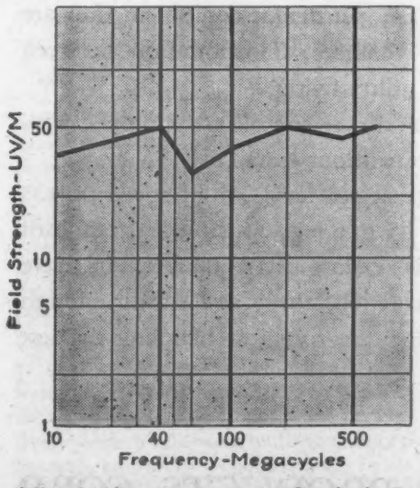
RADIO

## Aircraft Engine Radio Shielding Suggestions

A technical paper presented before the National Aeronautic Meeting of the SAE last month by D. W. Randolph of the Apex Electrical Manufacturing Company contained much helpful data concerning the reduction of noise in aircraft radio communication and navigation equipment.

Interference at moderately low radio frequencies, said Randolph, may arise from readily shielded or filtered voltage regulators, generators and other electrical apparatus as well as from the aircraft's ignition system. At high and ultra-high radio frequencies, however, such noise is largely radiated by the ignition wiring. Damping resistors in high voltage circuits is only a partial solution where sensitive receiving apparatus is employed so continuous metallic shielding over both low and high voltage ignition circuits is conventional.

The use of ungrounded lengths of conduit will, according to Randolph, result in noise radiation, as will the inter-connection of tubes or conduit of high specific resistance. In test work using calibrated equipment as specified in Navy Aeronautical Specification R-18a it was found that interference becomes marked if the resistance across a joint or at a grounding point is over .002 ohms. At .004 to .010 ohms interference is serious. Research shows that a safe resistance to be specified for connections in a new shield should not exceed .001 ohms. To obtain low resistance joints machined bearing services of adequate area must be provided. Non-metallic gaskets or anodized surfaces are, apparently, a source of trouble.




*Why shielding is necessary. Graph shows radiation from an unshielded system at various radio frequencies, measured with a vertical probe antenna located 90 ft. away*

Ground bonds between ignition shielding and the engine, it appears, should not be more than 18 in. apart. Where highly sensitive receiving equipment is used at frequencies of 100 mc. or higher bonds to the engine every 9 in. are desirable. The use of shields having a specific resistance of more than .005 ohms per foot requires even more frequent bonding.

Discussed at some length in the paper was the effect of moisture, corona acid products of the decomposition of air inside shielding upon ignition system insulation, the effect of conductive "tracks" forming upon the surface of insulators, the effect of damping resistors and capacitive loading in high tension circuits upon engine performance and sparkplug life.

Summing up, the Randolph paper said, significantly: "The recent tendency toward the design of an ignition system as a complete unit in itself seems to be the most logical and successful solution to the problem. Shielding, insulation, the spark generator and the sparkplugs must be designed to work together to obtain the maximum in efficiency and in trouble-free operation. Future progress seems to lie in the use of improved shielding having no internal air spaces, in the use of improved plastic or ceramic insulators, and in the development of new ignition systems in which low voltage currents are carried to individual spark coils in or near the sparkplugs to remove the necessity for high voltage distribution. Rapid progress has been made in recent months toward these objectives."

### Peek-A-Boo Insulation

"Transflex" is a new, tough, rubber-like insulation tubing developed by the Irvington Varnish & Insulator Company of Irvington, N. J., especially for use in connection with radio and other wiring in high-flying aircraft. Available in sizes from No. 12 to $\frac{1}{8}$ in. inside diameter, the tubing has good resistance to brittleness down to –50 deg. C, is transparent to facilitate the tracing of wires snaked through it and the location of breaks and shorts.

### Rubber In The Air

A rubber wind sock made by The General Tire & Rubber Company of Akron for trailing aircraft antennas gives proper drag for best radio performance, is suitable for use with hand or motor operated winches. The cone is $6\frac{1}{2}$ in. long but may be readily shortened for fast-flying ships. Diameter at the spider, which flexes to give straight, steady drag without spin, twist or whip, is $4\frac{1}{2}$ in.

The concern is also making rubber insulators in 3, 6 and 9 in. lengths (unflexed) for aircraft fixed antennas. In addition to insulating the antenna these units maintain antenna tension, avoiding the use of metal springs in which air friction frequently produces reception-disturbing static.

*Rubber wind sock for trailing aircraft antennas. . The spider flexes to give straight, steady drag without spin, twist or whip*

### Tubing-Shielded Wire Data

Excellent electrical as well as mechanical shielding of approved aircraft wire made to Specifications AN-J-C48 and 95-27074 is obtained by drawing over such wire seamless thin-wall copper, aluminum or lead tubing. The Precision Tube Company of Philadelphia presents interesting data concerning wire so shielded in Bulletin 201. Wire sizes from No. 2 to No. 22, with insulation ranging from flame-proof glass and flame-proof cotton to less expensive varieties, are discussed. Power factor in percent and capacity-per-foot between conductor and shield is tabulated. The bulletin states the outer diameter and

(*Turn to page 247*)

# PATROL PLANES FOR IMMEDIATE DELIVERY

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# Airline Progress and Mail Rates

By SELIG ALTSCHUL

WHILE the airlines show another year of progress in their 1941 annual accounts, the dominent note appears to revolve around the question of mail compensation. Either a protest is leveled against the threat of reduced mail pay or notice is served that increased mail compensation may be sought.

Reduced and retroactive mail compensation is now a reality for American Airlines by action of the Civil Aeronautics Board. It appears rather certain that retroactive adjustments will soon follow for Eastern. Mail revenues, which many have considered an element of declining importance to the airlines, continues to remain a fundamental factor making for success or failure in the industry.

It is true that mail income is constantly decreasing in relation to other revenues—particularly passenger. It is through the mail rate, however, that economic regulation is being exercised over the industry. Moreover, mail compensation has a far broader application than mere payment for postal service. As the CAB itself has stated: "The use of the mail payments is a statutory device for the accomplishment of national objectives that transcend the interests of the postal service." Mail rate determinations can not be dismissed as a mere percentage of total airline revenues; even the powers of economic control are overshadowed, being resolved into the question of enabling the carriers to fulfill their essential role in the war effort.

The CAB appears to recognize the special war problems in its "show cause" rate proceedings. Yet there is a definite conflict with this basic principle in the Board's decision on American's mail rates.

The American decision was the signal for the immediate lowering of ratings on all airline equities by a leading statistical service. However, once again this was nothing but belated recognition as the issues involved had already suffered price declines and the damage was done. When airline stocks were at relatively high levels—and with examiners' reports heralding reduced and retroactive mail payments—virtually every statistical service and many leading investment firms were recommending the purchase of airline securities. This department cautioned against the unbridled enthusiasm prevalent at the time and in August, 1941, stated: "The air transport industry can face the future with an assurance of long-term revenue expansion. New and broader markets in passenger, mail and express operations appear certain. *Many of the prognostications currently advanced, however, are nothing but tremendous build-up for a terrific let-down.*"

**Barron's Stock Averages**

| | Aircraft | Air Transport | 50 Stocks |
|---|---|---|---|
| April 3, 1942 | 31.30 | 14.75 | 60 |
| March 27, 1942 | 31.40 | 15.28 | 60 |
| March 20, 1942 | 32.22 | 16.25 | 60 |
| March 13, 1942 | 31.75 | 16.47 | 59 |
| April 4, 1941 | 36.55 | 21.52 | 72 |

Public sentiment is inclined to go from one extreme to another. Disturbing war news, increasing tax imposts and now the CAB action on American —have all conspired to dampen enthusiasm for airline equities. It is also true that the general market has been weak due to many similar depressing influences. It is possible, however, that when everything appears to be at its darkest, a turning point may soon be at hand. The discerning may find rays of encouragement to bolster sagging morale. Yes, even the Board's decision on American is not as detrimental as many have been led to believe.

Many statistical comparisons have been presented and are available which show the relative superiority of one airline over another. This may be stated in terms of gains in revenue passenger miles, revenues per ton-mile and by a combination of other statistical elements. Another measuring device and one that may be all-inclusive is the evaluation of investor experience in air transport equities. In other words, a $1,000 investment in an airline equity at a certain date, would be worth how much today? Similar determinations can be made for all companies, thus affording a clear-cut basis of comparison. This approach is used in the accompanying graph. The starting point is January 1, 1938, as at that date airline equities were near their lows and were about to anticipate the enactment of the Civil Aeronautics Act of 1938. Only the major companies having established

**GROWTH OF $1,000 EACH IN FOUR MAJOR AIR LINES ***

| | JAN. 1, 1938 | JAN. 1, 1939 | JAN. 1, 1940 | JAN. 1, 1941 | JAN. 1, 1942 | APRIL 1, 1942 |
|---|---|---|---|---|---|---|
| AMERICAN | $1,000 | 2,325 | 5,410 | 7,130 | 5,880 | 3,705 |
| EASTERN | $1,000 | 1,650 | 3,025 | 3,415 | 2,750 | 1,875 |
| TWA | $1,000 | 1,865 | 2,320 | 3,140 | 1,820 | 1,525 |
| UNITED | $1,000 | 1,760 | 2,225 | 2,210 | 1,535 | 1,175 |

*Graphic by PICK-8*

* Based on market quotations and adjusted for cash dividends. The peak and low prices for the individual issues were established at different intervals and at times other than the periodical intervals presented. They were as follows:

| | American | Eastern | TWA | United |
|---|---|---|---|---|
| Peak | $8,820 | $4,450 | $3,980 | $3,280 |
| Low | 940 | 1,000 | 730 | 690 |

place all companies on a comparable basis. None of the adjustments, however, cause any material deviation from the results shown.

The ebb and flow of the investor's airline fortunes can thus be seen over the course of recent years. For purposes of simplicity, comparisons are made at each year-end and April 1, 1942, is added to show the deterioration that has developed since the first of the year. Also shown is the high and low points of the individual companies, irrespective of the dates such levels were reached. This should stimulate some mental gymnastics for those who like to imagine what could have happened by buying at the bottom and selling at the peak.

The record shows that American paid off far better than any of the other major airlines. A faithful supporter, at the high mark during late 1940, could have realized almost $9 for the one invested at the outset of 1938. It is also evident that American suffered the greatest decline during the current first quarter—losing about 39 percent, primarily as a result of the CAB action. United, on the other hand, has consistently been a market laggard in relation to other airline equities. Moreover, at its low point, United showed the greatest loss in the group.

It is significant, however, that all major airline issues are currently selling at higher levels than prevailed more than four years ago when the industry was just beginning to show its stride and when it was about to be given a new lease on life by the enactment of the Civil Aeronautics Act of 1938.

Any new industry, having a sound base, is certain to show strong growth tendencies. The cycle of events is bound to carry many a company along with the tide. At times, the success of an individual unit may not be due to the enterprise of its management—but in being around when the inexorable trend of the times carries everything in its wake. The picture presented in the graph is a composite of all the elements contributing to the results shown for the individual lines. The market constantly evaluates all factors involved and its bloodless verdict is nothing more than a reflection of the progress being made by the separate companies.

### AMERICAN DECISION REVIEWED

The CAB decision on American Airlines—one that will have a profound effect upon the entire industry—is probably the most important rate pronouncement yet issued by the Board.

One of the fundamental issues involved is the recapture of past earnings. The examiners's report issued in June, 1941, first recommended that previously reported earnings be revised downward. Very little substance was advanced at that time and it appeared certain that if this principle were adopted, previously reported earnings of every airline would be in constant jeopardy subject to recapture.

Now comes the Board with its decision and in 13 well-documented pages asserts its right to order retroactive and reduced mail compensation for American. The weight of legal opinion marshalled to support this contention is imposing indeed, and it must be noted in all fairness, that a convincing case is presented. Basic considerations involved, however, are far broader than the narrow interpretation defined and adopted by the Board.

Probably the most outstanding section of the report is the Board's explanation outlining what constitutes proper notice that rates may be reduced as of a prior date. The Board, after some detail, stated that from the moment of the adoption of the order instituting the investigation, "the carrier has full notice of the possibility (of reduced and retroactive rates); . . . and such plans as it makes . . . it must make subject to the knowledge it thus possesses." *If this statement and supporting material means what it implies, there is strong reason to believe that the industry is not in universal jeopardy of earnings recapture.* In other words, unless the Board has instituted a rate proceeding for an air carrier, that company may reasonably expect to retain all earnings reported to date and until such time as the Board may serve notice that a rate investigation will be undertaken. On this premise, the only companies now subject to recapture of earnings are Eastern, Penn-Central, Pan American Airways and TWA. As far as the other airliners are concerned, the door appears closed as to the recapture of previously reported earnings.

Considerable uncertainty as to possible review of air mail rates may now be removed. The examiner's report clearly contained the possibility of establishing a dangerous precedent: the Board's action does not. Lumping the two together as one and the same, is the basis for the misinformed selling of all airline equities. At least statistical services and investment firms have not yet given recognition to the selectivity defined by the Board's decision.

The Board throughout its decision is cognizant of the substantial capital requirements of the industry, stating in part ". . . the close of the present war will open an era of airline expansion in the United States and in the international field without historic parallel. These developments will involve capital requirements of great magnitude, which in all likelihood will have to be met with great rapidity. They cannot be satisfactorily met unless those who supply the necessary funds are convinced that the enterprise will have a firm opportunity to secure earnings commensurate with the risk of the undertaking. The final measure of that risk will be determined by a number of factors, not least of which will be the economic results of the present regulatory policy now developing in the administration of the Civil Aeronautics Act."

Yet in the face of this sound dictum, the CAB action on American's mail rates is most disconcerting to those who have been led to believe that efficiency of management has its own rewards. Further, the Board, with high regard, quotes an opinion of Mr. Justice Brandeis to the effect that: "The reasonable rate to be prescribed by a commission may allow an efficiently managed utility much more."

Based on results, American has demonstrated a superior record. This is shown in the substantial revenue passenger gains from year to year and is reflected in the overall barometer presented. The Board itself credits American with "a very creditable performance on the score of honesty, economy and efficiency of management." The "need" of the carrier seems to be the controlling factor. Under such circumstances the Board is inclined to reduce all airlines to the same level with the resulting tendency of discouraging individual incentive.

The Board found that 98 percent of American's total operating expenses of the immediate future will be covered by non-mail revenues. Obviously, under such circumstances, the "need" of air mail compensation to American is very small and loses all relation to its economic value.

The minority report of Chairman Pogue is very enlightening. The constructive suggestion is advanced that an economic regulatory policy be followed which would encourage a simple capital structure confined entirely to common stock thus avoiding the complicated structures and attendant difficulties of some public utilities. This is particularly germane to the airlines as there have been indications of preferred stock coming into greater popularity.

The Chairman also recognizes the desirability of establishing "funded" reserves to meet the heavy financial demands of the future. The recommendation is made that Congress authorize the Board to require the airlines to maintain such funded reserves which would be created out of compensation received for the transportation of mail and out of funds received from general commercial business. These reserves, under the proposal, would be normally available upon authorization of the Board, and only for operating expenses and not for

(*Turn to page 260*)

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AS, day by day, the stern lessons of aerial warfare over Europe were driven home, there formed in the minds of the men of Republic Aviation a new concept of fighter aircraft . . . of a plane which would *fly higher*, *fly faster* and *outfight* any other airplane in the world.

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With the concurrence of Government officials, actual planning of the project was swiftly carried forward by Republic Aviation engineers. An intensive period of designing, building and testing ensued, during which valuable aid was rendered by Pratt & Whitney Aircraft division of United Aircraft Corporation, pioneers in the development of great aircraft engines. In all, an incalculable amount of human endeavor and skill was brought to bear so that our Army pilots might have a pursuit-interceptor which would be second to none.

Today the prospect of victory is brighter because of Republic Aviation's unflagging efforts and devotion to a single purpose. The premier designation in the field of high-altitude interception has been officially accorded the new and mighty Republic 2000-h.p. P-47 THUNDERBOLT, significantly described in the Harter Report of the House Committee on Military Affairs as "the most suitable aircraft of its type in the world."

This selection of the P-47 as one of the limited number of basic types of warcraft being produced under the Victory program is a crowning recognition of the soundness of Republic design and of the success of a resolute enterprise in which the Army Air Corps has shared importantly.

Now, the steady and ever-increasing output of Republic *P-47 Thunderbolts* at Republic Aviation's great plant at Farmingdale, New York, is to be augmented by companion production at other points.

To our distinguished brothers-in-production on the P-47, we of Republic Aviation cordially extend full collaboration and the aid of every facility at our command to *keep the Thunderbolts rolling.*

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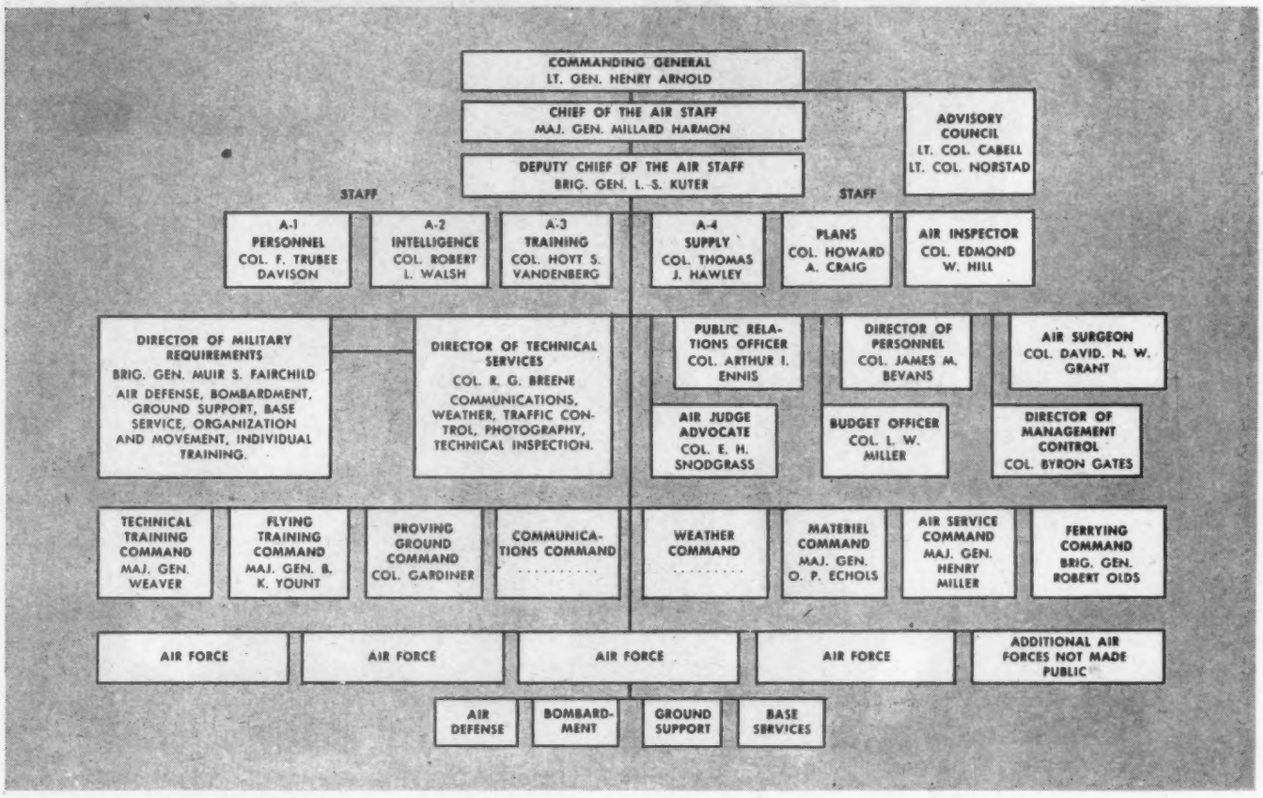
**REPUBLIC** REPUBLIC AVIATION **AVIATION**

**Organization chart of the streamlined U. S. Army Air Forces and functions of the new components explained.**




# Organization of the AAF

By BLAINE STUBBLEFIELD
*Washington Editor, Aviation*

THIS CHART shows the set-up of the Army Air Forces as newly constituted under the general Army reorganization. It is compiled by AVIATION from data furnished by the AAF public relations section. Names of commandants of the various departments and sections of course are current and subject to change at any time.

Most people think of this Air Force picking up and going away to war, a unit at a time. That isn't the way it works. The Air Force is a vast training school. All these officers and their sub-commands and their air bases and laboratories, and airplanes and men constitute a school. This school sends out trained men to join task forces in the theaters of war, under other commanders. And it helps design, and procures airplanes for them.

At the top you see the commanding general and his chief and deputy chief of staff. The staff itself is shown in the next lower six boxes: A-1, A-2, A-3, etc. The advisory council, in the box at right, works only with the commanding general.

The next lower bank of sections—two big ones on the left and six smaller at the right, pretty much explain themselves. Notice that the old Air Corps has been abolished. You see various of its functions scattered in the new organization.

The eight boxes across in line, third from the bottom, are separate commands, reporting direct to the Commanding General, not through other commands, as they used to. That is the main change for speed of action; it does away with "layering" directives and orders up and down. The Materiel Command is the one that develops and buys airplanes.

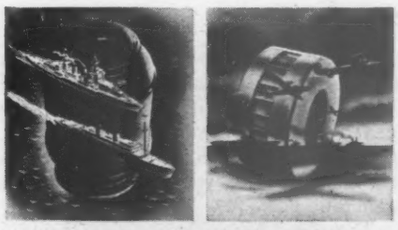
Next to the bottom are shown four Air Forces. These were attached to the four armies, but we do not know what their status is now. Presumably there are now more than four. The bottom bank shows the four parts of each.

# *Ears that hear miles into the sky*

SENTRIES of the night must glean even the faintest murmur of an airplane in the skies. From this sound, the location and direction of flight must be determined, searchlights pointed, the plane identified, and, if necessary, intercepted.

To do this, the sensitivity of the human ear is magnified and made keenly aware of direction by the huge mechanical ears of the Sperry Sound Locator.

This instrument is but one of the many units manufactured by Sperry to increase the efficiency and effectiveness of the armed forces.



Among Sperry products playing a vital role in the war effort are the Gyro-Compass, Gyro-pilot, Directional Gyro and Gyro-Horizon.

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## New Atlantic Speed Record Established

A civilian ferry pilot flying an American bomber to England recently got on a tail wind and made the trip in 6 hr. 40 min., clipping an hour from the previous record. The distance is about 2,400 miles; average speed about 330 mph. After setting the mark, with a Consolidated *Liberator*, the pilot still had too much gasoline for safe landing and he was compelled to circle the field for three hours to lighten his load. It is against the rules for ferry pilots to speed on crossings and violations are punished, but the pilot in this case convinced authorities that his speed was accidental. The rule against speed is to keep restless pilots from using up their engines by running them too wide out.

*Acme Photo*

*Liberator sets new record for Atlantic crossing*

# Military

for several months. The planes are being delivered to various concentration points throughout the country by pilots of the Ferrying Command.

*Press Association Photo*

**Bagged Six Japs**

*Lieut. (j.g.) Edward H. O'Hare sits in the cockpit of his Navy shipboard fighter in which he knocked down six Japanese heavy bombers. Note the "notches" for each kill, consisting of miniature Jap insignias on the side of his plane. His victims were part of a force of 18 bombers which attacked a U. S. aircraft carrier west of the Gilbert Islands.*

## "Grasshoppers" For AAF

Delivery has begun on an Army Air Force order for a substantial number of L-57A light observation planes manufactured by the Taylorcraft Aviation Corporation of Alliance, Ohio. This designation supercedes the previous designation, O-57A, to better identify the mission of this particular airplane. that of liaison work in conjunction with the ground forces.

The L-57A differs from the Taylorcrafts previously purchased by the Army in the extension of the window area, including the entire roof of the cabin, to a point along the upper surface of the fuselage about midway to the tail. Another change is in the installation of a swivel seat for the observer in the rear of the cabin and a shelf upon which calculations may be made. It is powered with a Continental 65 hp. engine.

The current order will keep the Taylorcraft factory at capacity operations

*Photo by Frank A. Hoiles*

*Taylorcraft L-57A liaison plane for Army Air Forces*

*Belly tank increases Airacobra's range*

## Bell P-39D Airacobra

The Bell P-39D *Airacobra* carries a belly tank to augment its normal fuel supply. The streamlined tank can be dropped in flight, when desired, after its contents are exhausted.

This Army fighter, powered by the Allison liquid-cooled engine, carries the heaviest cannon of any single fighter in the world. This model has been in volume production for some months. The *Airacobra* is also in service with England's RAF, whose pilots rate its high in combat performance. Its armament also includes heavy and light machine guns.

The engine is located just aft of the pilot and the propeller drive is accomplished by means of a ten-foot extension shaft to a reduction gear in the nose. Its 37 mm. gun fires through the hub.

WHAT questions regarding aircraft engine lubrication or the selection of aviation fuels and lubricants would you like to have answered?

The Aviation Division of The Texas Company has the answers to many such questions, and wants to send them to you.

This material, written in layman's language, has appeared in our technical publication, "LUBRICATION."

It will be found thoroughly reliable, authentic, and technically accurate.

Requests for the number of copies desired by aviation schools, students and employees in the aviation industry will be honored until the supply is exhausted. There is no charge. Please address your requests to:

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*"You maintain 'em, we'll fly 'em," say these cadets. Maintenance of equipment used in training student pilots is one of the vital phases of our war effort.*

# Primary Flight Maintenance

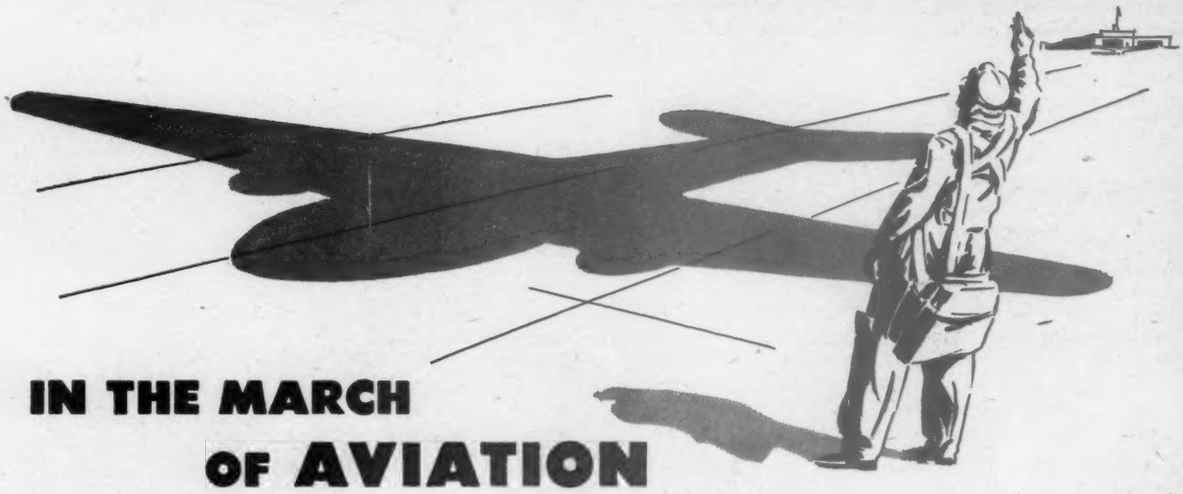
**Civilian schools now under contract to train Army pilots are doing the miraculous, largely through the diligence and ingenuity of the maintenance personnel. This is dramatically illustrated in the following story of maintenance technique at Hawthorne School of Aeronautics.**

By **WILLIAM D. STROHMEIER**
*Flight Commander, Hawthorne School of Aeronautics*

NOT, BY ANY MEANS, the easiest maintenance job in aviation is the problem confronting the superintendent of maintenance at any of the nation's Civil Elementary Schools, where commercial contractors are using Army flying equipment to give Air Corps cadets their first taste of flying. These schools scattered throughout the south, southwest, and west are today chalking up a remarkable performance in making possible not only a quick, efficient training program for the Air Corps but also chalking up the safest military training record in the world. No little credit for all this must of course be handed to the maintenance crews who after all are the ones who keep 'em out of the shop and on the line.

This stellar job of maintenance being carried on at these Air Corps Training Detachments by civilian crews under army supervision, has in no way been made easier by the recent stepping up of the entire program of military pilot training. The latest plans for tens of thousands of planes has had its corresponding effect on the number of pilots wanted in a hurry. The primary schools have been called on to increase their output to a marked degree, and much of this increased load has been placed on existing facilities and fleets of training planes not enlarged in proportion. In short, the ability of schools to produce

# AS WE PASS OUR 10TH MILESTONE



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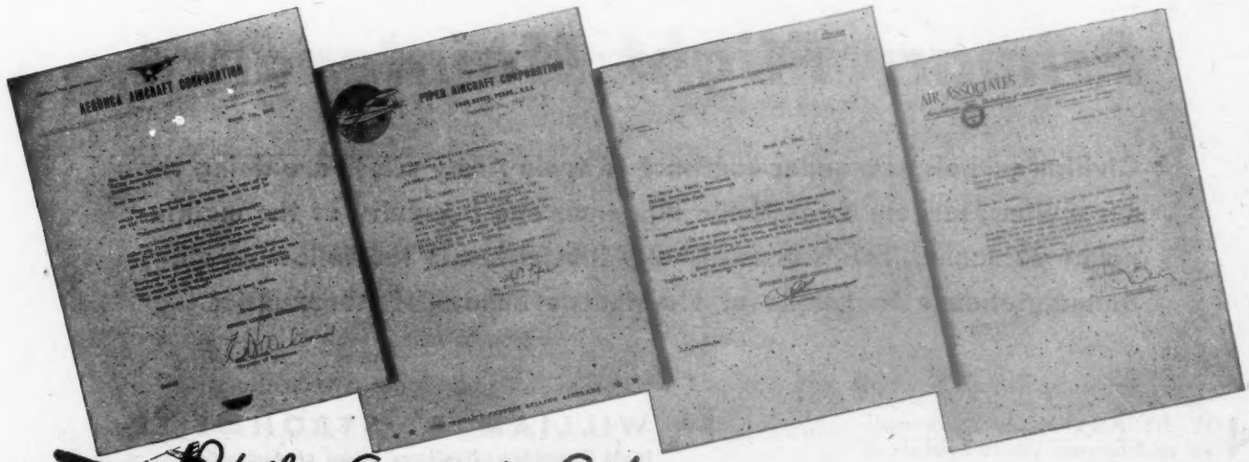
IT CAN BE DONE. To this determined spirit of American aviation, we at Uniloy pledge our support. The past decade has well prepared us for all-out service to Military and Light-aircraft manufacturers during the present emergency. ★ ★ Much has been asked of Uniloy—our entire organization is complying—7 days a week!—with skill, accuracy and patriotic vigor. And we're ready to do even much more! ★ ★ Uniloy facilities and engineers are today prepared to cooperate with aircraft manufacturers in the design and production of accessories and special equipment. Your letter will bring a prompt response.

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Suppliers to U. S. Army Air Corps

## Maintenance

*Above: Engines are shipped to Army Air Depots for overhaul. At left is an engine complete with cowling on special stand ready for installation. With this arrangement, two men can change engines in two hours. Right: Hawthorne inspection crew at work. The cowling and fuselage of the PT-17 can be quickly opened for inspection and repair. Removable bottom plate makes it possible for man to stand upright inside of cockpit to work on controls.*

has revolved mainly about their ability to keep as many airplanes possible in the air a maximum amount of time. It has called for new, ingenious and clever ways of avoiding time consuming hours off the flight line. That these problems are becoming satisfactorily overcome is a tribute to civilian aviation and its personnel which, trained by years of experience, are now available to help in the victory effort.

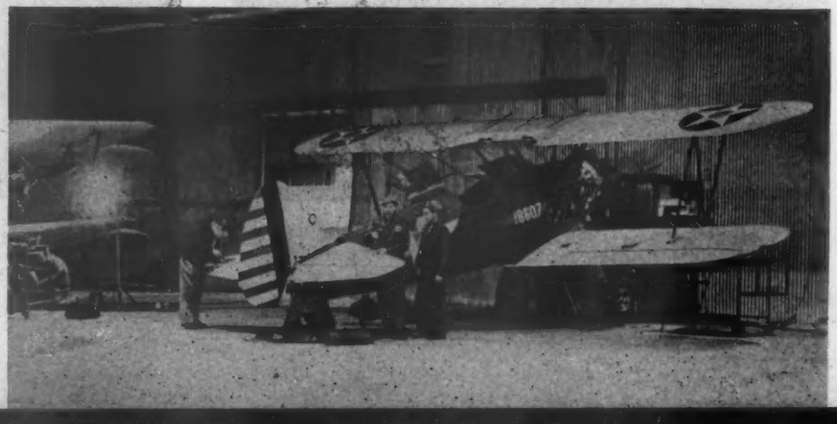
An excellent example of the scope and perplexity of maintenance problems confronting primary schools may be found at the Hawthorne School of Aeronautics. This school, located in Orangeburg, S. C., is under the South East Air Corps Training Center and is typical in all respects of the many schools turning out primary aviation cadets. In keeping stride with the stepped up program it has put to work many ideas which "keep 'em flying," longer.

Hawthorne's maintenance superintendent is Sam R. Monschke, a typical product of civilian aviation. Born and raised in Texas, he started his aviation career washing airplanes for rides. Gradually going up the typical ladder of promotion he became connected with Braniff Airways at Dallas, later a teacher of aircraft mechanics at North Texas Agricultural College, where he was formerly a student, and finally maintenance supervisor of the Civilian Pilot Training Program in the second region. From the latter position, Monschke came to Hawthorne where in a few short months he organized from scratch a compact and efficient ground crew to handle the fleet of Stearman PT-17's used by Hawthorne for the training program.

While many factors entering into successful CPTP operation have a bearing on proper operation of an Army contract school, the increased size of the fleet of airplanes to be serviced, the more complicated nature of the airplanes themselves, the much more rigid Army standards and maintenance requirements, make the problem or rather business of maintenance one full of many complications. Not the least of these problems in setting up a maintenance crew on short notice was the procurement of sufficiently experienced men and mechanics. It is a well known fact that aircraft mechanics are even more scarce than good pilots. It has been found, however, at Hawthorne, that except for key personnel of the maintenance group, as satisfactory results can be obtained with local men of good intelligence as with the average run-of-the-mill aircraft school graduate or A. and E. mechanic. Since the work is entirely specialized on one type of airplane, the Stearman, an employee with a diversified knowledge of all types of aircraft and engines has little advantage. The routine and constant repetition of the same type of maintenance methods and procedures make it possible to quickly groom a reasonably inexperienced helper into a responsible

(*Turn to page 248*)

*Right: Complete records of flying time and maintenance work done on every airplane are kept on master sheets posted on these boards. Below: Hawthorne inspection crews get to work on PT-17's after the end of a flying day.*



## GM War Service Program

The recent announcement by General Motors Corp. of its three-point program to help keep the planes, tanks, and guns of the United Nations at highest possible fighting efficiency finally throws the spotlight on that vital phase of the war effort—maintenance. Heretofore the greatest emphasis has been on production, where indeed emphasis was deserved. But as the war is to be won only by machines *in use*, much of the burden of the war effort falls squarely on the shoulders of the maintenance men who must keep them in useful condition.

The three-point assignment taken on by GM includes the following:

1. Help train the enormous number of mechanics required to keep a modern task force in motion by maintaining schools for Army and Navy instructors.
2. Place its own engineers in the field to expedite reports on operating experience so that war products can be improved constantly.
3. Assist the Army and Navy in having replacement parts on the spot when needed.

The training job alone calls for expenditures totaling as much as $5,000,000 for the current year. It will involve the training of thousands of instructors in scores of centers throughout the country.

Special staffs have been set up to conduct this program with key GM men appointed to head each of its phases under the direction of C. L. McCuen, GM vice-president in charge of engineering.

W. J. Davidson will have charge of the Engineering Service group consisting of engineering observers stationed in each Army Area and in each theatre of war. M. D. Douglas will handle parts distribution.

John E. Johnson is head of the Department of Training Service and will be directly concerned with the training of maintenance instructors.

Some GM divisions, such as Allison and Chevrolet, already have schools for Army instructors in operation, and these will be expanded. Other divisions will launch schools of their own. Teaching will involve products originated by other manufacturers which GM is now producing, as well as GM designed products.

The training program follows the design, standards and regulations set up for the armed forces and known as the Four Echelon System. Under this system the enlisted personnel are trained for four different types of maintenance work. In the first echelon are the men who operate the equipment in the field. In the second echelon are field mechanics working from light repair units. The third echelon includes men in semi-mobile shop units where major repairs and replacements are made; while the fourth echelon covers overhaul depots.

The largest and most difficult training job undertaken by the armed forces is the Army Air Forces program. The Allison Division of GM, producer of liquid-cooled aircraft engines, has been training Air Force men for some time and has already given more than 800 men of Allied nations from one to three months training as instructors. The Allison school is scheduled for expansion under the new program.

# Maintenance

In addition to operating a school at its plant, Allison also operates "road schools" at depots and flying fields. Furthermore, instructors are maintained at basic aviation training centers operated both by the Air Force and by commercial training schools.

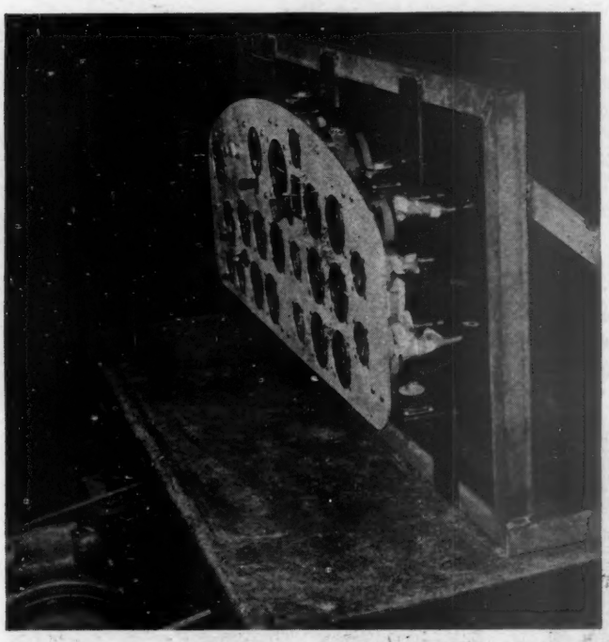
Courses of instruction similar to those at Allison will be set up in connection with the production of airplanes and aircooled aircraft engines.

Besides the airplane maintenance training schools, GM is also preparing to train men for service with the other military branches involving tank, diesel engine, armament, and truck maintenance.

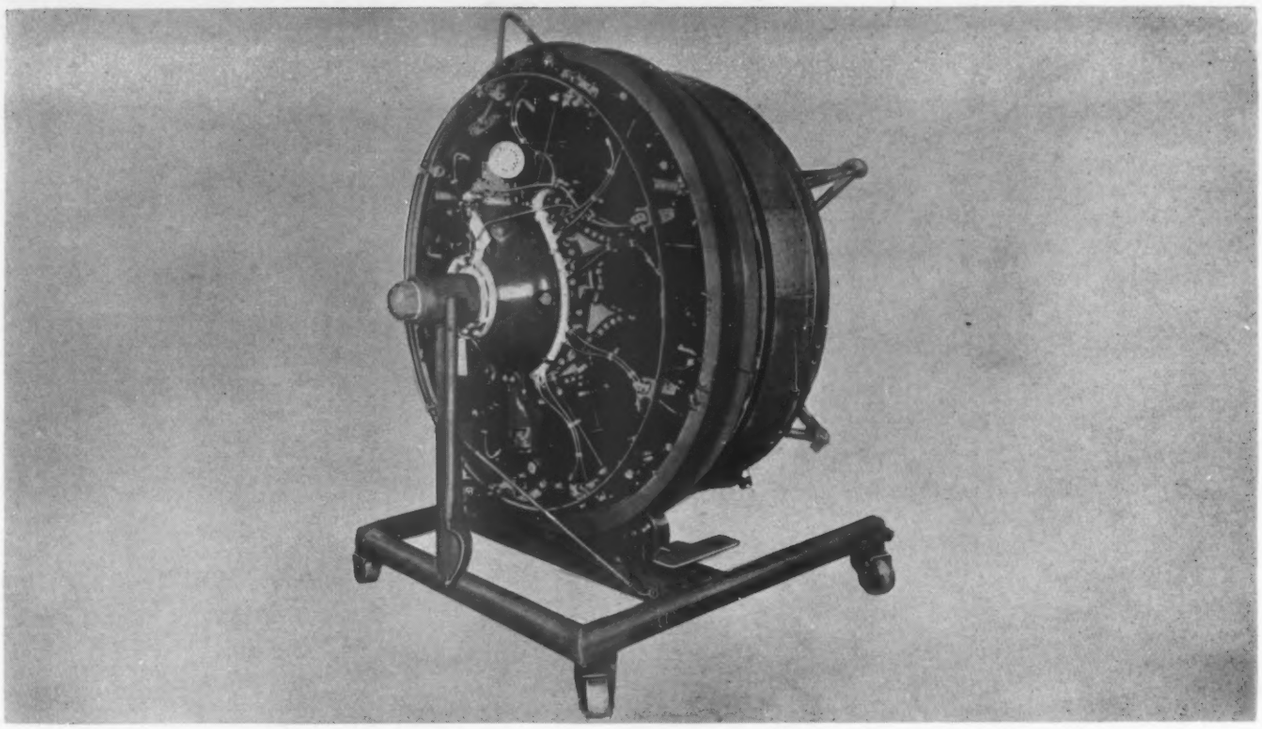
## Panel Vibration Test Stand

To determine vibration isolation characteristics of instrument panel mountings under severe vibratory conditions, a panel test stand has been devised by North American Aviation consisting of a power-driven vibration source, panel mounting jig, and a standard instrument panel assembly.

In the accompanying photographs the stand is shown testing the vibration isolation characteristics of Lord Shear Type Mountings manufactured by the Lord Manufacturing Co. of Erie, Pa.



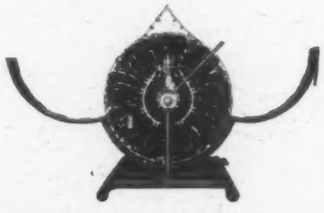
*LEFT: Instrument panel vibration test stand. RIGHT: Panel testing jig vibrating 2,400 rpm. The panel is still, demonstrating efficacy of mounting.*



# Announcing the Type "RA" Unit

## an Example of Whiting's Specialized Service to the Aviation Industry

### Engine Quickly Locked in Whiting Type "RA" Unit



In four simple steps the engine is locked in place.

1. Open arms of supporting ring.
2. Slip shaft support on propeller shaft.
3. Lower engine and shaft into position as shown above.
4. Close ring arms and clamping device.

Brake holds engine in desired position. Spanner wrench is provided to turn crankshaft, which is supported by bronze bearing.

The new Type "RA" Unit is a simplified device for holding radial engines in an easily accessible position during the assembly of the engine accessory section. Important features are the rotating ring clamp which permits turning the engine about the crankshaft axis to any desired position and the modern streamlined design which provides 100% accessibility to any part of the accessory section. The new and unique design incorporated in the Whiting Type "RA" Unit has provided every possible means of speeding up nacelle assembly. The engine is quickly and easily clamped into position; the entire streamlined unit is easily maneuverable in congested spaces.

Whiting products include service-tested matched maintenance and handling equipment—metal working machines—cranes and hoists. Whiting engineers develop new devices to customers' specifications, and the research staff is equipped to work with you in solving your equipment problems.

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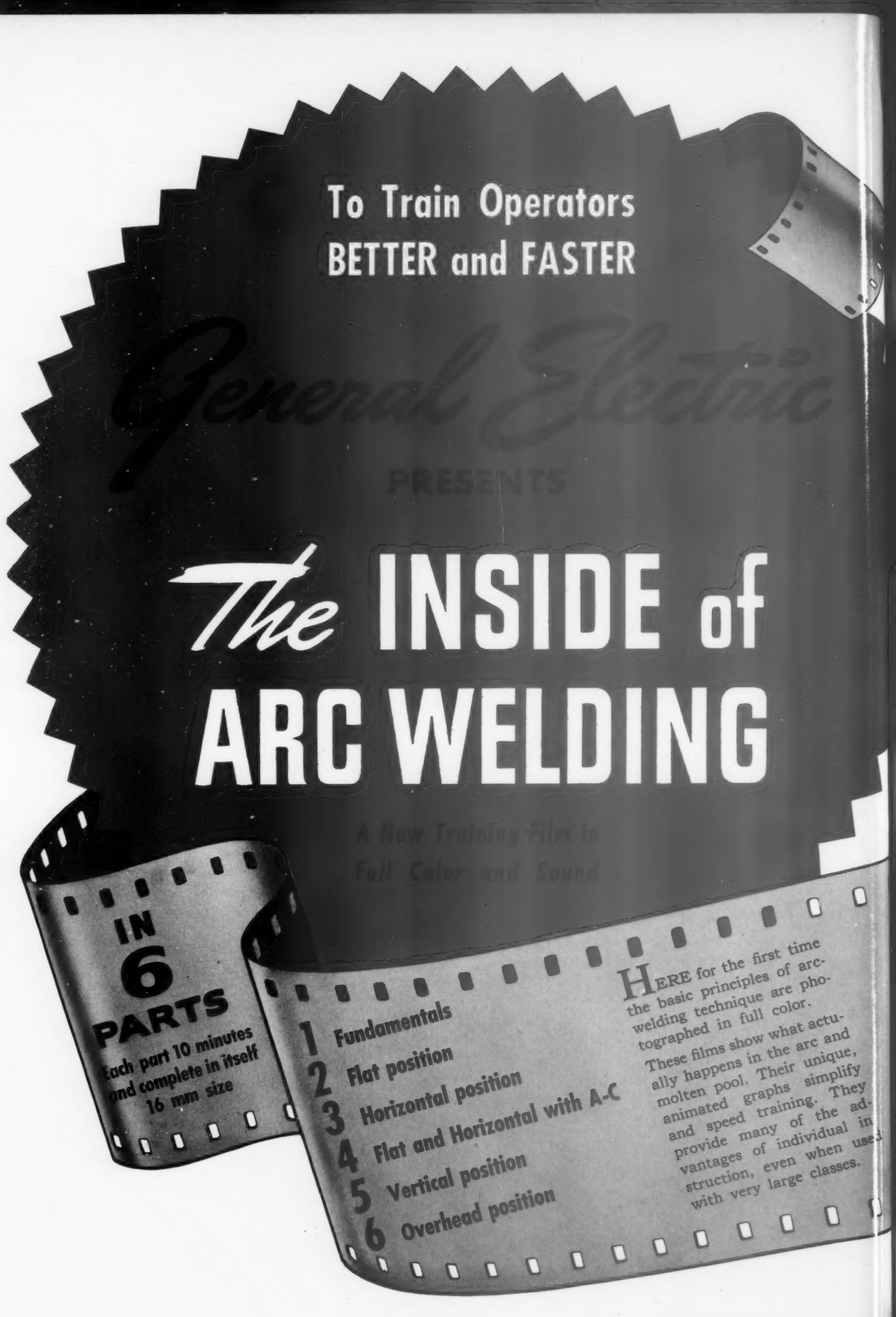
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3 Horizontal position
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These films show what actu-
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**The arc and molten pool** are shown in detail—made possible by a new technique developed by Raphael G. Wolff Studios of Hollywood. You see why electrode travel-speed and position are so important.

**Animated cross sections** show how the covering protects the arc and how the metal is melted off the electrode, mixed with the base metal, and deposited with a protective slag covering on the resultant weld.

**Joe MaGee** portrays, in animated cartoon portions, the groundless fears of the beginner at striking the arc, lending a humorous and effective bit of understanding and interpretation.

**Experienced operators** demonstrate the basic principles of shielded-arc welding. The use of movies makes it possible for all students in a large class to see these demonstrations close-up.

**Quality welds,** as well as poor ones, are illustrated by cross sections. The good and bad points of typical welds are shown by full-color shots, and their causes are fully explained.

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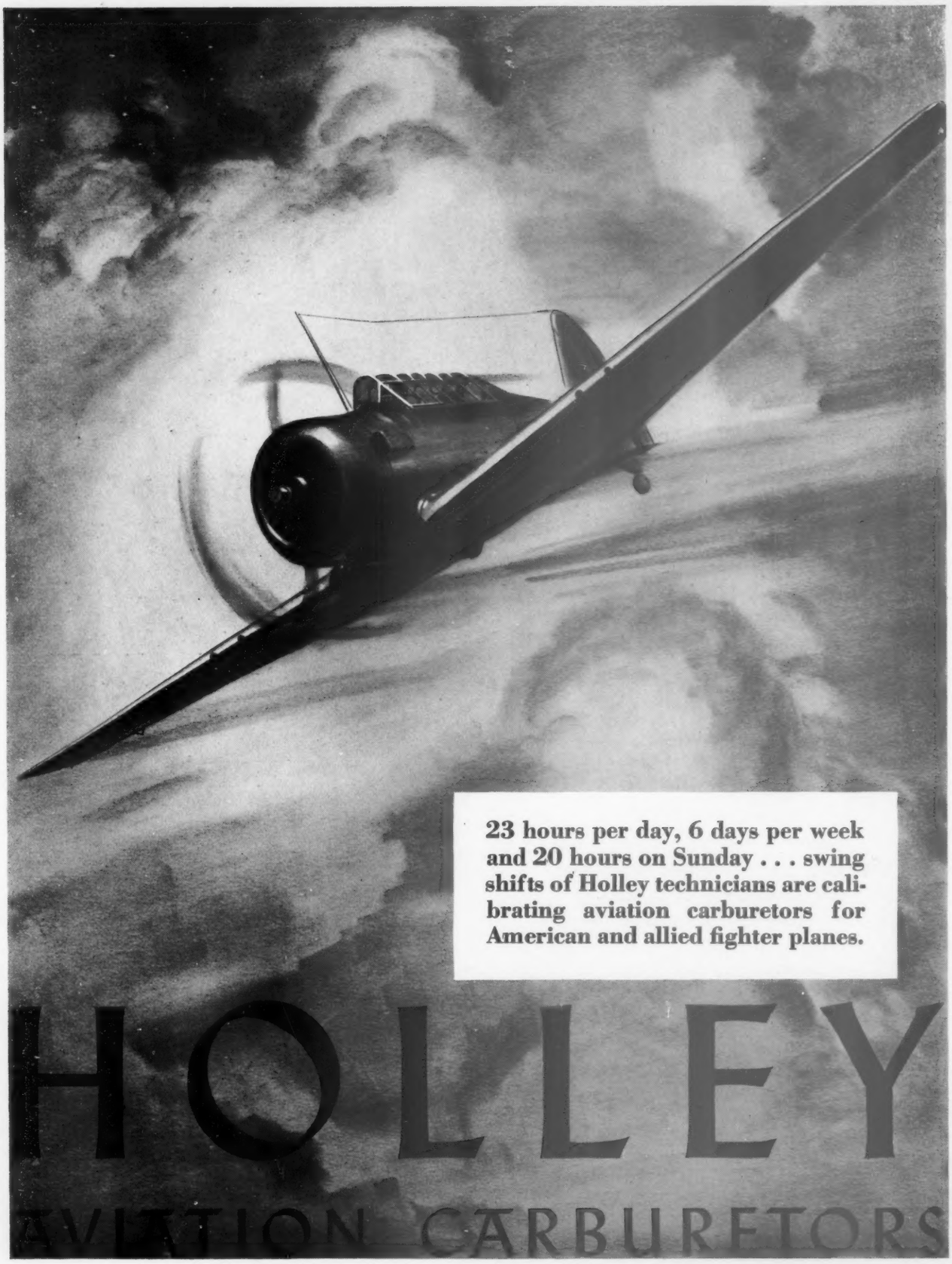
23 hours per day, 6 days per week and 20 hours on Sunday . . . swing shifts of Holley technicians are calibrating aviation carburetors for American and allied fighter planes.
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The instrument panel is flexibly suspended at three points along the top and three points at the bottom. Each flexible support consists of two standard 150P Series Lord Plate Form Mountings connected in series through the center sleeve. The metal outer-member of the top mount is attached to the jig and that of the lower mounting is riveted to the instrument panel bracket. Metal snubbing washers, placed at the top and bottom of each series mounting assembly, contact the rubber snubbing shoulders of the mountings during periods of resonance and limit excessive movement of the mounted system.

## Thermometers and Compasses

Some notes of interest to maintenance men are contained in the safety regulation releases prepared by the Aircraft Engineering Division of the CAA. Two recent releases deal with vapor-pressure type aircraft thermometers (release #99) and magnetic compasses (release #103).

The releases contain complete descriptions of the instruments with much interesting information concerning the purposes and uses of them; the correct installation procedures; and an analysis of the probable causes if trouble is experienced in their operation. This analysis is reprinted here. It is to be noted that, for the most part, remedial action involves sending the defective instrument to an approved repair station in that only duly certificated persons can make repairs or alterations on instruments in certificated aircraft.

### Faulty Instrument Guide

*Aircraft Thermometers (Vapor-Pressure Type)*

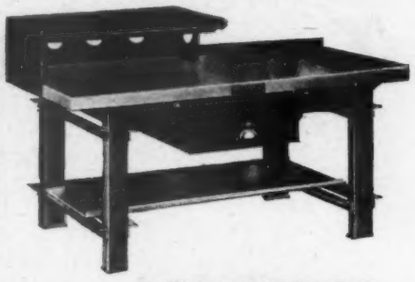
| *Trouble Indicated* | *Probable Cause* | **Remedial Action* |
|---|---|---|
| 1. High indication | Indicator out of calibration | Remove from aircraft and send to approved repair station. |
| | Vibration effects on pointer | Improper installation of the indicator. |
| | Capillary improperly installed | Ascertain that anchorage location of capillary is such as not to be affected by heat from engine on exhaust manifold. |
| 2. Low indication | Indicator out of calibration | Remove from aircraft and send to approved repair station. |
| | Vibration effects on pointer | Correction of possible improper installation of the indicator. |
| 3. Thermometer inoperative or sluggish in pointer movement | Capillary tube kinked or constricted | Remove from aircraft and send to approved repair station. |
| | Excessive friction | Same as above. |
| | Loose parts | Same as above. |
| 4. Erratic pointer indication | Excessive vibration | Check the panel installation with a vibrometer. The total amplitude of vibration should never exceed .004 of an inch in any direction. |
| | Capillary tube kinked or constricted | Remove from aircraft and send to approved repair station. |
| 5. No indication—pointer falls below lowest point on the scale range | Liquid or gas exhaustion | Replace with a serviceable instrument. |

*Magnetic Compasses*

| *Trouble Indicated* | *Probable Cause* | **Remedial Action* |
|---|---|---|
| 1. Card visibility obscured | Discoloration of damping liquid | Remove instrument from the aircraft and send to an approved station. |
| | Luminous material paint faded or deteriorated | Same as above. |
| 2. Card or pointer movement sluggish | Broken pivot jewel | Same as above. |
| | Dull pivot | Same as above. |
| | Defective transmitting unit | Same as above. |
| 3. Card not level | Card element unbalanced, broken, or leaky float | Same as above. |
| 4. Lubber's line misaligned | Loose or broken | Same as above. |
| 5. Leakage of damping liquid | Cracked glass or bowl | Same as above. |
| | Leaking filler screw plug | Same as above. |
| | Loose bezel screws with leaky gasket | Same as above. |
| 6. Card or pointer element erratic in flight (calm air) | Excessive vibration of the installation | Check the installation with a vibrometer. The amplitude of vibration should not exceed .004" in any direction. |
| | Variable magnetic fields present | Check electric wiring, switches, shielding of electrical instruments, etc., for variable effects. |
| 7. Lighting system defective | Bulb defective | Replace bulb. |
| | Fuse in circuit defective | Replace fuse. |
| | Resistor defective | Replace resistor. |
| | Loose connections at the plug connector | Check for loose connections or poor contact of plug connector. |
| 8. Deviation is excessive when checked with known magnetic bearings or during flights when operating any electrical equipment that affect the compass heading | Variable magnetic fields present if the indication is erratic at intervals | Check electric wiring, switches, shielding of electric instruments, radio influences, etc., for effects. |
| | Permanent magnetic fields changing due to causes previously described | Compensate the compass by swinging the aircraft. |
| 9. Correction card lost | Carelessness | Same as above. |

*To be undertaken by certificated repair stations having an instrument rating.

To Get the Job Done in a Hurry . . .



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Challenge Work Benches are ruggedly built of iron and steel to remain rigid under heavy pounding, shocks, and pressure. The surface and all four sides of the cast-iron top are at exact right angles, carefully planed. The underside is heavily ribbed—the legs are firmly braced, and the braces are high enough to permit the use of a standard lift truck if the bench is to be moved.

Challenge Work Benches are made in four sizes, three styles. Ask for details and prices at once!

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LATEST CATALOG illustrates and describes complete lines of Challenge Precision Equipment. Send for it today! 415

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GRAND HAVEN, MICHIGAN

# Turning Out Instrument Pilots

**How Pan-American Airways instructs its flying personnel in transoceanic instrument flight routine**

By HENRY W. ROBERTS
*Pan American Airways System*

"SOUND BASIC instrument flight training is absolutely essential to the successful operation of a scheduled airline," say PAA's operating veterans. This is made possible throughout the PAA System by use of the formula:

$$\frac{\text{High Standard} + \text{Good Instruction}}{\text{Good Equipment}} + \text{Actual Practice} = \text{Expert Instrument Ability.}$$

This is the simple formula which gave PAA its unexcelled flying personnel, and the lowest accident rate among the world's airlines. Every PAA pilot is, in the true sense of the word, an expert. When, on December 7, war broke out in the Pacific, PAA's "California Clipper" was stranded in New Zealand. Its crew flew the ship to New York—via Australia, East Indies, India, across Africa, across South Atlantic, and up to PAA's base at LaGuardia Field—under wartime conditions and in virtually total radio silence, in an uneventful "routine" operation. For a whole month the big flying boat was a self-sustaining unit, operating away from its bases, away from established air routes.

But such epic flights are, to PAA personnel, merely "routine." That flight was, perhaps, the most spectacular demonstration of the value of the company's formula.

In addition to instructing its own personnel in expert navigation of oceangoing aircraft, PAA is also training an undisclosed number of transoceanic ferry pilots. PAA's instructors teach the ferry pilots—but who teaches the instructors?

Many years ago PAA's dynamic vice-president, A. A. Priester, felt that the

*A Grumman G-44 used by Pan American as an instrument trainer. The plane is equipped with two complete pilot compartments, one behind the other. The instructor and his co-pilot occupy the front compartment, while the trainee flies on instruments in the enclosed rear compartment.*

*Above is the student pilot's compartment. It is complete in every respect except for flap and landing gear actuating controls. Ahead of the panel and curtain which cuts off the student's forward vision is the instructor's compartment. Actually, the instrument panel shown here is not the standard training panel, but one being used to test an experimental Sperry gyro-stabilized magnetic compass. After completion of the test, the standard panel will be replaced. Above, right: Standard instrument training panel mounted in the student's compartment.*

special operating problems of his airline required special flight instruction. Without fanfare, at several of its far-flung bases, PAA's operations department set up flight instruction projects. In long test flights, under all sorts of operating conditions, actual or simulated, PAA's early pilots taught themselves. There was nobody then who could teach them. From the lessons they learned themselves there evolved a training procedure for making flying experts out of mere pilots.

### SPECIAL OPERATIONAL PROBLEMS

Today, PAA maintains eight training centers at its various bases, uses 17 training ships. In addition to routine flight training, taught equally at all stations, each station also instructs its personnel in the special operational problems encountered in each division. Thus, the pilots undergoing training at the Pacific Division in San Francisco go through extensive practice in instrument approaches and landings which they may encounter in the waters of San Francisco Bay, Los Angeles Harbor, in Hawaii, Midway, Wake, Guam, Manila, Canton, Pago-Pago, New Zealand, and alternate emergency harbors, while those in training at the Atlantic Division in New York become familiar with the same problems as applied to the harbors at New York, Baltimore, Bermuda, Azores, Lisbon, and alternate ports of call.

Most of the preliminary training is done on such aircraft as may be spared from actual operation; some of it is being done in small two-place Rearwins, or four-place Cessnas and Stinsons; for flying boat training, old Sikorsky S-38's and Consolidated flying boats are being used. After the pilot becomes well versed in the flight problems which he will encounter, he is given final training on board the actual types of aircraft which he will fly: Douglas DC-3A's, Stratoliners, two- or four-engined Sikorsky S-42's, or Martin Clippers, or the new giant Boeing 314 flying boats.

*Ward D. Davis, Senior Instrument Flight Instructor, Atlantic Division, Pan American Airways System.*

Of the 17 training airplanes now in service, three are located in the Atlantic Division at New York, six at the Eastern Division at Miami, one at the Pacific Division at San Francisco, another two in the Western Division at Brownsville, and one each at Seattle, and in Colombia, Brazil and Peru.

### SPECIAL MARINE EQUIPMENT

The latest marine equipment, especially designed for the task, is used by the Atlantic Division at New York, and consists of three Grumman Widgeon type G-44 twin-engined amphibians. This equipment represents a major milestone in PAA's training program, and although publication of complete details of these unique ships is not possible under present wartime conditions, some items of interest may nevertheless be presented without disclosing information essential for national defense.

Each divisional instrument training project is under the direction of a senior instrument flight instructor. At the Atlantic Division the training project is under the direction of Division Instrument Flight Instructor Ward D. Davis.

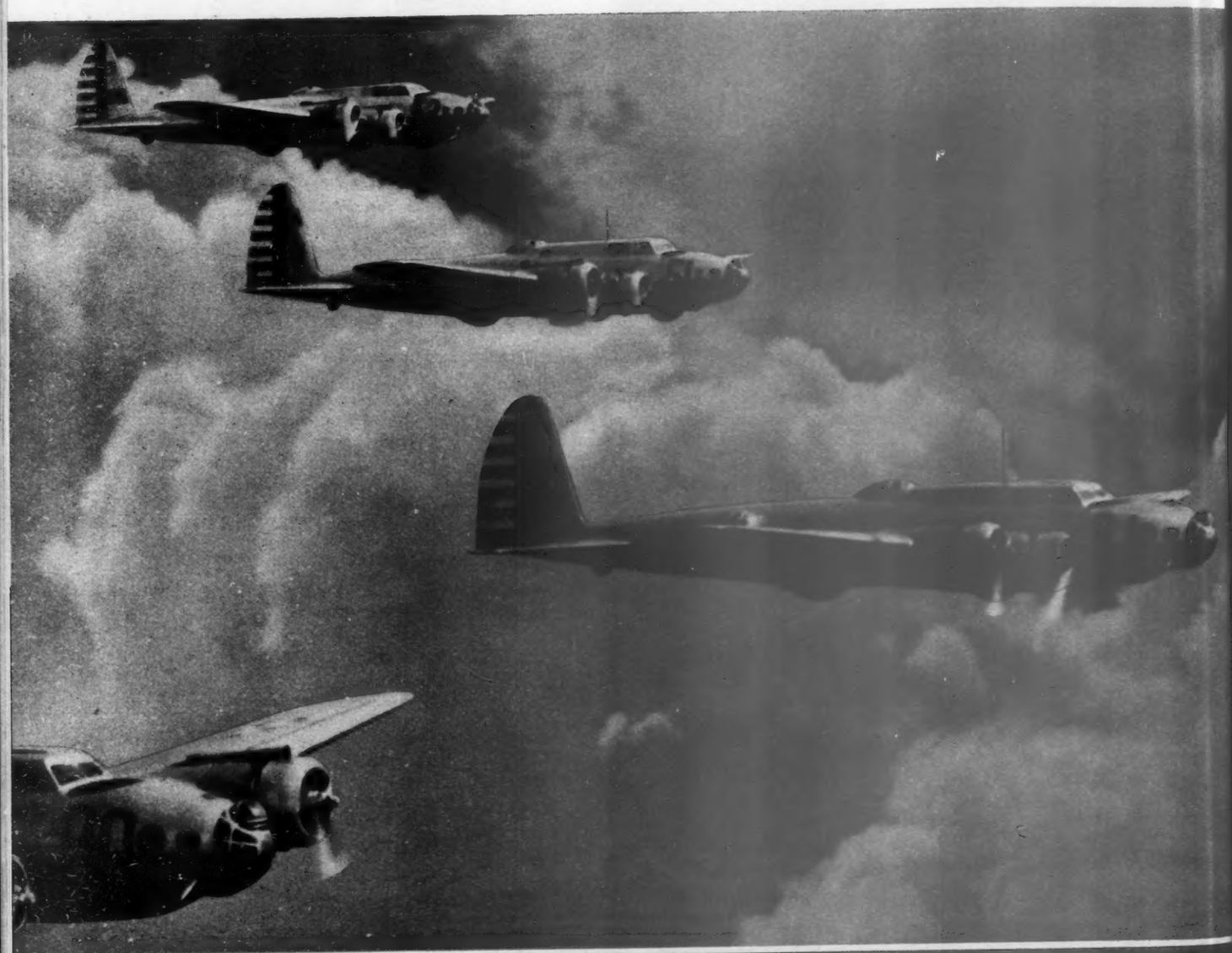
His three Grumman Widgeons are each equipped with two complete pilots' compartments, one behind the other. The instructor and his co-pilot are seated in the forward cockpit, while the pilot undergoing training occupies the rear cockpit which is completely equipped

(*Turn to page 243*)

TO SPEED AIRPLANE PRODUCTION—

# *Alloy Steels*

of known uniform behavior in fabrication



# REPUBLIC *Alloy*

From the many Republic Alloy Steels—each of known uniform physical characteristics—designers and engineers can select the most efficient steel for each specific plane or engine application. Included in this wide range of analyses are steels that provide the needed high strength to weight ratio; resistance to creep, stress, shock, vibration, abrasion and corrosion; working safety at high or low temperatures—or any combination of these essential qualities.

But selection of the correct grade is one thing—working it into the required shape is another.

That's where Republic Alloy Steels again come to the aid of the Aviation Industry—by providing known uniform behavior in fabrication that speeds production—uniformity of flow under the forging hammer—uniformity of machining under cutting tools—uniformity of reaction when given various types of heat-treatment—uniformity in welding—consistency in results time after time.

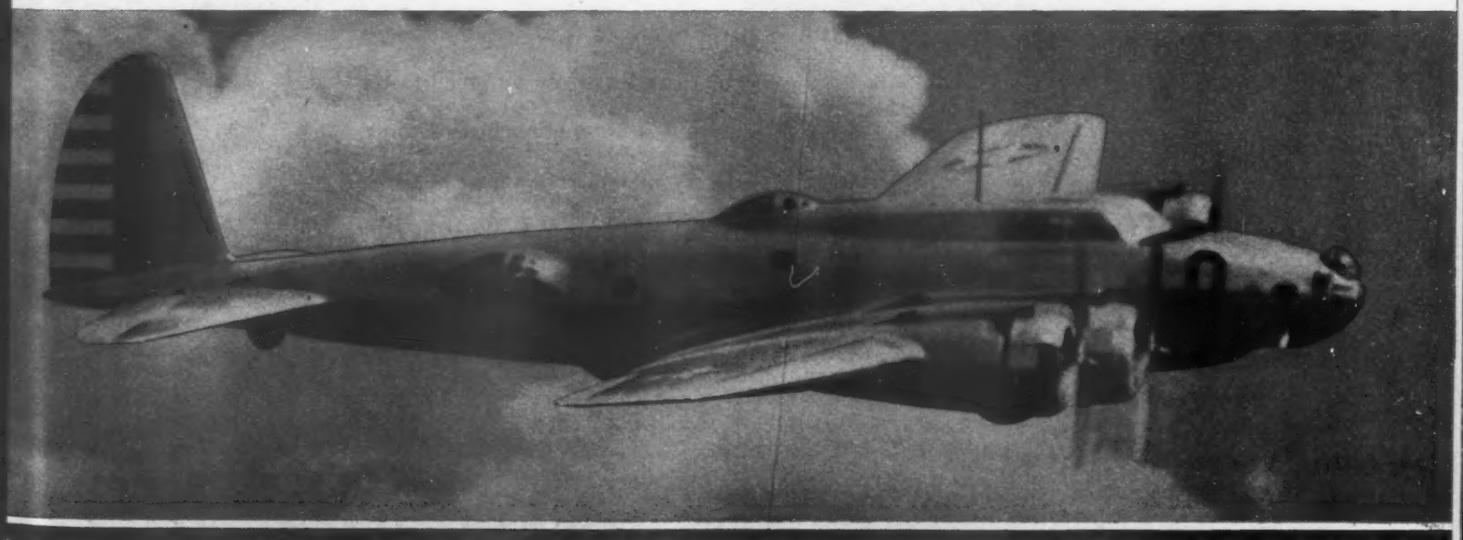
With such uniformity of results in fabrication, production moves along smoothly and rapidly—helping to increase output—America's greatest need today.

Republic metallurgists—with accumulated experience in "aircraft quality" steels dating back to before the days of World War I—with unequalled experience gained through Republic's position as the world's largest producer of alloy and stainless steels—are qualified and ready to assist Republic customers on any problem involving the selection, application or fabrication of steel.

And Republic's tens of thousands of expert steel makers are utilizing every ounce of Republic's tremendously increased electric furnace capacity to supply more steel—better steel—in a full-out effort to speed *Production for Victory.*

**REPUBLIC STEEL CORPORATION**

Alloy Steel Division Sales Offices: Massillon, O.
General Offices: Cleveland, Ohio
Berger Manufacturing Division
Culvert Division
Niles Steel Products Division
Steel and Tubes Division
Union Drawn Steel Division
Truscon Steel Company






*Official Photograph, U. S. Army Air Corps.*

# STEELS

Other Republic products include Enduro*, Stainless Steel—Electrunite* Aircraft Tubing—Upson Bolts, Nuts and Rivets—Pipe—Sheets—Truscon Hangar Doors and Building Products—Berger Lockers and Shelving.

*Reg. U. S. Pat. Off.

● **Designers of machines for America's armament can speed up production by specifying bearings of established American *standard* dimensions and tolerances. Because *standard* bearings can be produced much faster than "specials" requiring extra tooling and different machine set-ups.**

**One "special" may well delay delivery of many *standard* bearings and the machines awaiting them, in addition to complicating the servicing of machines in the field or in the plant. New Departure, Division of General Motors, Bristol, Conn. Detroit and San Francisco.**

3084

**Designers:** *Consult a New Departure Engineer as to availability of types and sizes.*

**Managers and Foremen:** *The proper mounting of ball bearings so that machines will give tip-top performance is vital to our war production effort. All men in charge of assembly should have New Departure's new "Shop Manual."*

*Left: Wood monocoque construction, except metal pilots' compartment, is used in the Beech AT-10, powered by two 280 hp. engines and equipped with automatic pilot. Below: A Cessna Bobcat reaches for the sky.*

# Transition Trainers . . . .

**Extensive use of these planes is saving money, lives and priceless time for the United Nations.**

TO FLY the AAF's multiengine tactical airplanes, immediately after the completion of flight training in primary, basic and advanced single-engined trainers, would be something like trying the big jump after the first few skiing lessons.

The multiengine pilot has 2,000 to 4,800 "horses" at his command. He has many more tons of airplanes to fly, and is responsible for larger crews than single-engined pilots. The big multiengine planes handle differently on the ground, during take-off and landing, and in flight. Multiple instruments and controls surround the pilot and co-pilot and teamwork with the crew is infinitely more complex than the instructor-student team in single-engine trainers.

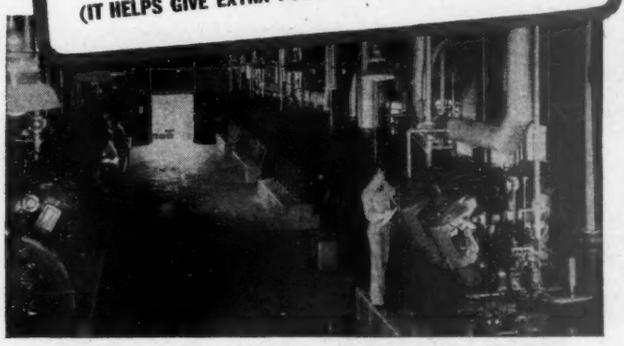
In peacetime, single-engine pilots were schooled in the intricacies of multiengine flight on obsolete combat aircraft. The situation which faced our military experts at the start of the war was a perplexing one. Multiengine pilots by the thousands were needed. So was every multiengine combat craft in existence, obsolete or not. The prospect of having to take these badly needed planes away from the battle front for training purposes was gloomy indeed.

(*Turn to page 255*)

*Above: The Cessna Crane, an important factor in the Empire Training Program, about to take off. Below: The Curtiss AT-9 was designed for training pilots of multiengine fighters and bombers. It carries a full complement of training instruments, including an automatic pilot.*

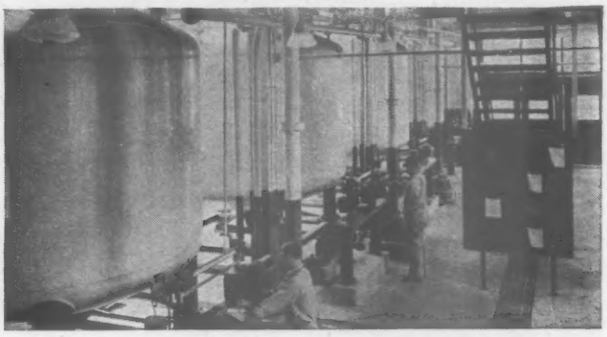
# Can you identify this industry?

(IT HELPS GIVE EXTRA POWER TO AMERICA'S WARPLANES)

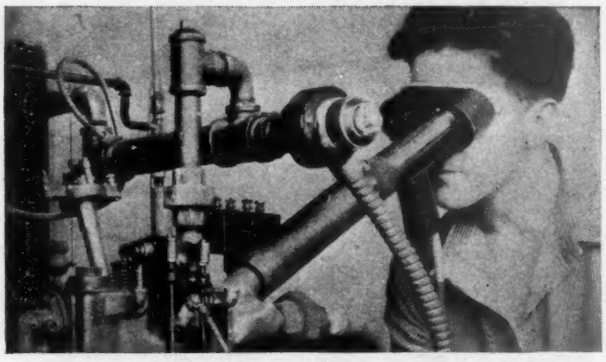


**CLUE No. 2** . . . The battery of compressors above is used to compress petroleum gases to make ethyl chloride. This chemical is very necessary—but there is not a drop of it in the finished product.

**CLUE No. 1** . . . The basic raw materials used are—salt, sulphur, sea water, molasses, lead and petroleum gas. This picture shows part of the equipment for evaporating salt brines to produce table salt.

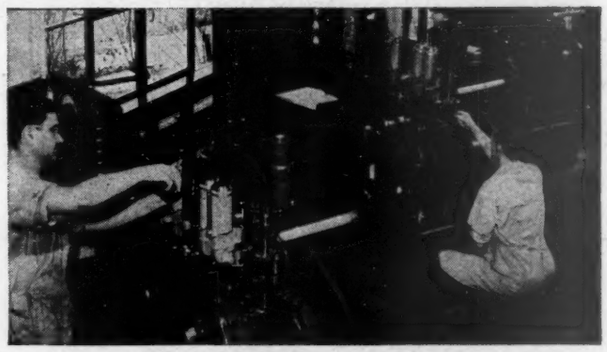


**CLUE No. 3** . . . Tons of the various ingredients that make the finished product are blended in these weigh tanks at one time. They measure the ingredients accurately to within one part in ten thousand.



**CLUE No. 4** . . . This research engineer is using an optical pyrometer to tell, by color, temperature of an exhaust valve in an engine running "wide open." Research is very important in this industry.

**CLUE No. 5** . . . Painting a drum to ship the product overseas for war use. Each drum is cleaned and painted gray each time used, so the least leak of brightly colored product would show immediately.



**CLUE No. 6** . . . The final clue is an easy one—if you're an automotive or petroleum engineer. These machines are "C.F.R." knock rating engines which are used in the six gasoline-testing laboratories.

**It's probably no secret to you by now**—these are a few pictures of the company that produces Ethyl brand of anti-knock fluid. Oil refiners use Ethyl fluid to produce the high-octane gasolines that give extra power to America's warplanes, tanks and other motorized equipment. Fortunately, the Ethyl Corporation has sufficient plant capacity to supply all war needs without delay and still produce anti-knock fluids for improving gasoline used in the tractors, trucks, buses and passengers cars of our motor transportation system.

**Flying Equipment**

*Each of the photos shown here are of a different model of the Westland twin-engined fighter. This one has its radio mast just forward of the cockpit.*

# Westland Whirlwind

**In service with the RAF since before the war, here are the first details released on Britain's twin-engined, singe-seat fighter.**

*The plan view of the Whirlwind is illustrated in this overhead shot. Notice the camouflaging in which one wing is black and the other white. Observe also the reversed RAF "bull's-eye" on the black wing.*

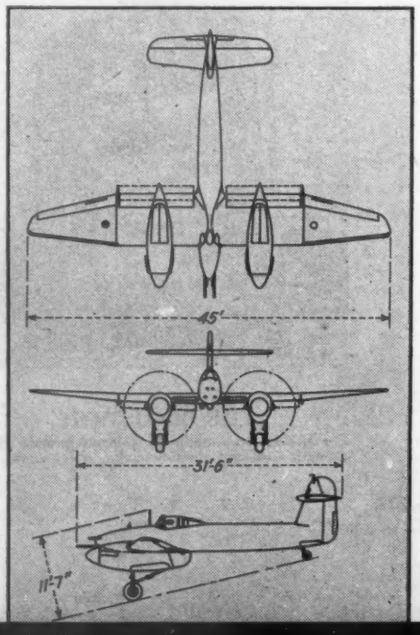
FIRST DETAILS of a British single-seat fighter, the Westland *Whirlwind*, equipped with two liquid-cooled engines, have recently been revealed. Hitherto, no information has been officially released on this type of military plane employed by the Royal Air Force, although it is said the *Whirlwind* was flying more than a year before the war began in September, 1939. Last August *Whirlwinds* were reported to be part of an escort, as far as Antwerp, in bombing raids on Cologne. They are used both as day and night fighters.

Powered by two 12-cylinder Rolls-Royce *Peregrine* engines, which develop 860 hp. each at 13,500 ft., the *Whirlwind* is said to have a top speed of 353 mph. Span is 45 ft., length 31 ft. 6 in., and height 11 ft. 7 in. These dimensions make it smaller than our twin-engined Lockheed P-38, which also has considerably more power in its two Allisons. Armament on the *Whirlwind* consists of four 20 mm. Hispano cannon. These are installed in the nose of the rather narrow fuselage. A distinctive feature is the cruciform tail, the center of which has been faired. Flaps of the Fowler type have been fitted and the rear ends of the engine nacelles are hinged so as to move with the flaps to which they are attached. In the night-flying version, retractable landing lights are installed under both wings, and flame-damping exhausts are fitted.

Both main landing gear and tail wheel are fully retractable, the main wheels retracting backward into the underslung nacelles behind closing doors. Radiators are totally enclosed in the wing between the fuselage and engines, as shown in the three-view drawing, the cooling air entering by way of ducts in the wing's leading edge. Diameter of the constant-

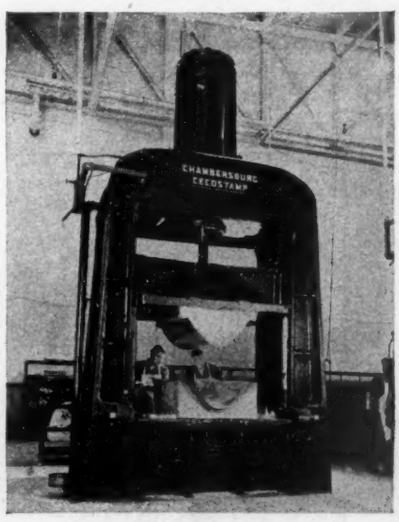
(*Turn to page 256*)

*This 3-view of the Westland Whirlwind was taken from an official German recognition book which also supplied the dimensions and speed.*



# Cecostampings

***PROPELLER SPINNER. Made of stainless steel on a 66" x 48" CECOSTAMP. Rubber rings used extensively for the deep draw.***




**THE CECOSTAMP**

**The modern drop stamp for difficult forming of high strength steel and aluminum alloy sheet metal parts.**

HIGH STRENGTH metals, such as stainless steels and many aluminum alloys, present a forming problem that taxes the most modern type of stamping machinery. Many forms cannot be drawn without a great deal of difficulty—other forms must be shaped without drawing as no reduction of section is permitted!

The Cecostamp provides a means for forming these difficult metals with fewer operations and greater true-to-die accuracy. The Cecostamp permits the operator to control the metal flow of stamping and thus produce shapes without drawing and the reduction of sectional areas.

Controlled stamping overcomes the resiliency of these hard-to-form metals and gives them a permanent set at a greater rate of production.

A new publication, just off the press, shows examples of Cecostampings and details of their production. Just write for a copy of "Cecostampings".

***Chambersburg Engineering Co., Chambersburg, Pa.***

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**★ CECOSTAMP ★**

**HAMMERS PRESSES**

# Civil Air Patrol Steps Ahead

**Earle L. Johnson succeeds Maj.-Gen. Curry as commander**

LARGE SCALE military operations by the Civil Air Patrol are likely in the immediate future as CAP's potentialities become more and more apparent to Army and Navy officials. This is indicated by reports from Washington concerning the success of "test" Wings operating with various Army commands throughout the country.

Courier service by CAP is proving itself of great value to the Army, particularly for the transportation of cargos comprising replacement parts needed for the servicing of military aircraft. More than 1,000,000 pound-miles of Army cargo alone were flown in a ten day period despite bad weather by the Pennsylvania Wing servicing the Army Air Depot at Middletown, Pa. Cargo mileage will continue to increase as more ships of the Stinson *Reliant* and Beechcraft class are drawn into service. These ships are capable of transporting (with one pilot) nearly 1,000 pounds of cargo 600 miles non-stop at speeds around 150 mph. Besides cargo flying, personnel transportation is also increasing. Army officials are being flown as far south as Georgia and South Carolina by the Pennsylvania Wing at Middletown.

In western sections of the country, Wings are flying patrols over strategic areas where distance between such areas is such that aircraft patrol is the only feasible means for efficient operation. The Illinois Wing is preparing to assist in the collection of scrap metal for the War Production Board by locating all abandoned automobiles and farm machinery from the air. Much time will be saved in this quest as all reports of material will be tabulated as to location, permitting the appropriate agencies to route their collection personnel more effectively.

Air raid alerts in several cities have been given added emphasis through the use of CAP planes. One hundred and forty-seven aircraft and 400 aircrew personnel staged an "air-raid" on Indianapolis. In South Charleston, W. Va.; ten planes were used to check civil defense operations including the dispatching of police and fire units to "bombed" areas by radio.

CAP also has directly aided the Army by flying patrols over anti-aircraft batteries in training maneouvers thus allowing regular Army craft usually assigned to this work to be given more important military duties. Civil craft and personnel will, no doubt, be used more extensively on this type of work as the personnel becomes more cognizant of military training procedure.

Use of CAP personnel has been suggested by Charles I. Stanton of the CAA as a means of easing the "airport guard" situation. Mr. Stanton in a letter to Maj. Gen. Curry said, ". . . we have advised municipalities or airport managers to apply to the CAP for volunteer assistance in meeting the personnel requirements for guarding and flight control . . . We are sure that the CAP units will feel it is a part of the service they can render to the country."

*Earle L. Johnson succeeds Maj-Gen. John F. Curry as National Commander of Civil Air Patrol. A Quiet Birdman and director of aeronautics for Ohio, he organized Ohio pilots for defense flying before the advent of CAP. His rise from executive officer to present office suggests War Department confidence in Patrol to handle its own affairs properly*

This is possibly the best solution to this problem as there are more than enough CAP personnel to be assigned this type of duty. Last reports are that 37,000 persons, of whom 80 percent are pilots, have applied for CAP duty.

CAP aid in reporting subversive activities to the FBI has been covered in a letter from J. Edgar Hoover, director of that well known organization. He says, "I believe that the personnel of your Patrol could be of great assistance by reporting immediately and directly to the special agent in charge of the nearest field office of this Bureau any activities coming to their attention which indicate possible violations of the Espionage or Sabotage Statutes. . ."

It is stressed that each CAP intelligence officer should contact his nearest FBI office so that he will know to whom to report, and how he can be reached by the agent in charge should occasion arise.

All Patrol Wings are carrying out extensive ground training courses which are pertinent for efficient cooperation with the Army and Navy military problems. Radio training is being particularly stressed because of its importance in plane-to-ground communications. Units have been instructed to enlist as many "hams" for CAP duty as is possible. Experienced mechanics are also needed for the servicing of light aircraft while on prolonged duty.

Added proof that the CAP has graduated from the "kiwi" class and is ready for close Army and Navy cooperation was demonstrated by the recall of Maj.-Gen. John F. Curry and Maj. Reed Landis, national commander and aviation consultant, respectively, to active Army duty and the assignment of Earle L. Johnson as national commander of the CAP.

Due to War Department censorship, details are meager concerning many important duties and operations that are yet to be given to the CAP, but the appointment of Mr. Johnson suggests the confidence that the Army and Navy has in the ability of the CAP to handle its duties properly, in line with established War Department policy. From all indications it appears that the Patrol will become a more important adjunct to our armed forces than many supposed; in truth, an auxiliary air arm (See AVIATION, *February*, 1942, page 82).

## Trailers To Planes

The shortage of metal and metal workers has caused many concerns to look to wood as a possible substitute to keep them going under existing war conditions.

One concern, heretofore not connected with the aviation field has converted its machinery from that of building house trailers to the production of gliders. Three other such trailer concerns are already converting to build wooden aircraft.

# 99·9% efficiency...

IT is well over two hours now since the ship's twin engines roared once again into life and the tarmac at Halfway airfield started slipping hurriedly away from the cabin windows. The Lawes River with its attendant pastures and creeks is just over one hour and two hundred miles behind us to the West, and already the patchwork landscape ten thousand feet below is changing from wooded foothills into, flat lush plain. Away now, to the right, the main coast arterial is slicing diagonally across country to join the broad, traffic-spattered ribbon of the State Highway beneath us. Soon they will dive together as one wide boulevard into the tangled environs of the City, and the great ship will start its wide down-spiral to the airport. Dates fixed for the half-hour after the ship's arrival will be kept to time. Nothing uneventful has happened on this swift, luxurious hop from capital to capital. Nothing uneventful was expected to happen. In modern travel we take full efficiency for granted.

But what **is** 'full efficiency'? Certainly it is not—and never can be—100%. That is beyond the bounds of human atainment. But if we can attain 90.9%—then that is as near as human endeavour will ever get to perfection. **And in one of the hundred-and-one things which go to make aircraft efficiency this amazingly high percentage has been obtained. In Filtration.**

After much long and painstaking research in the VOKES laboratories, filters incorporating and entirely different principle of filtration have been evolved which have been proved under most stringent practical tests to filter down to particles 0.00004 ins. diameter. **As near as is humanly possible** this means pure air and pure oil (the VOKES filters are available for both air and for high and low-pressure oil systems), and a consequent great increase in the working-efficiency and life of aero engines. The introduction of these 99.9% efficient filters is of paramount importance to the aircraft industry. We shall be pleased to answer enquiries and arrange practical demonstrations through our agents.

Type of cleaner for updraught carburettor on Radial engine.

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American and Canadian Agent:
E. Cantin, 101 Park Av., New York

In line with this, several aircraft companies which are producing metal ships at the present are also conducting research on wood and resin-bonded veneers in the attempt to produce aircraft that are less costly and quicker to build. Some notable success has been achieved along these lines and the woodworker appears to be coming back into his own, regardless of whether he formerly built trailers or chairs.

## ALONG THE APRON . . .

• *The Casey Jones School of Aeronautics* in Newark, N. J. reports that the majority of mechanics students formerly enrolled as private students have been accepted as "Mechanic Learners" under civil service, with appropriate pay. Upon graduation, they will be placed under contract at any of the big Army Air Corps bases servicing Army aircraft.

• *Air Cadet eliminations* in the Primary School at the Southeast Air Corps Training Center have been reduced by 7 percent due to a physical training program started last summer. Thirty-four games, drills and aquatic exercises including archery, badminton, basketball and swimming are part of the physical training program which is improving coordination for flight duties.

• *Link-Instrument Courses* are the subject of two "letters of intent" which have been mailed from CPTP service headquarters in Washington. Courses include 15 hours minimum on a Link trainer, 20 hours aloft or a maximum of 25 hours. Contract to be for $810, including $100 for subsistence for trainee.

• *Air Service Command,* Wright Field has placed training contracts with ten schools in the "A-E" and specialist categories. The command will absorb full capacity of the schools signed. Future likelihood is that every approvable aviation training facility in the country will be training airmen for the nation's offensive effort.

• *Offering its service* and aeronautical testing facilities to the light plane manufacturer, the University of Kansas has announced the addition of a department of aeronautical engineering with a four year course leading to a B.S. degree in aeronautics. . . . Equipment includes three wind tunnels, largest of which is 5 ft. in diameter with wind speeds up to 85 mph., and various other testing apparatus for aircraft and engine testing and research. Engines up to 500 hp. can be handled. Shop facilities for the construction of models and parts and a university owned airport are also on hand. . . . E. E. Brush, associate professor of aeronautical engineering is in charge. He was formerly a research engineer for Lockheed.

• *The CAA* is anxious to preserve as much civil aviation as is practicable throughout the war because it believes that such aviation has a potential contribution to make in the war effort and that it would be unfortunate to destroy civil and commercial aviation and have to recreate them at the conclusion of hositlities.

• *There still seems to be some misunderstanding* as to the permissibility of flying to and operating at points other than designated landing areas. Clearance officers at designated airports have the authority to clear flights to points

*Neuman Studio, Fort Wayne, Ind.*

**CAP GROUP RECEIVES PLANE**

***Group 3 of the CAP Indiana Wing has received an Aeronca for patrol use from a patriotically-minded business group in Fort Wayne, Ind. Group Commander Dr. Beaumont S. Cornell (second from (right) and officials of the donating firm are shown before the plane just prior to its christening by screen actress Martha Raye. Later 28 CAP planes took off on their first official mass flight in the state. Several emergency flights have been made to check on low flying ships over defense factories. All flight leader planes are being equipped with two-way radio.***

## Civil Operation And Training

which are not designated landing areas, provided they are satisfied as to the nature and purpose of the flight, and that the airplane will be guarded.

• *Trained for commercial flying service overseas,* eight former graduates of the CPT commercial and instructor courses recently completed their advanced Flight Officer training at the Pilot Training Division of Northeast Airlines, Inc., at Burlington, Vt. 184 more CPT graduates will take the nine-week course which includes advanced meteorology, navigation, radio and instrument flight practice, Link time and multiengine flying.

• *One hundred hours free flying time* and a year's employment at regular salary will be given to each of the 100 winners of a Wings for Youth Competition sponsored by the Piper Aircraft Corp. of Lock Haven, Pa. Maximum age for entrants is 19 years. Contest calls for the construction of a scale (not solid) model of the Piper *Cub* Trainer and closes July 8, 1942. Details may be obtained from local newspapers or from Piper.

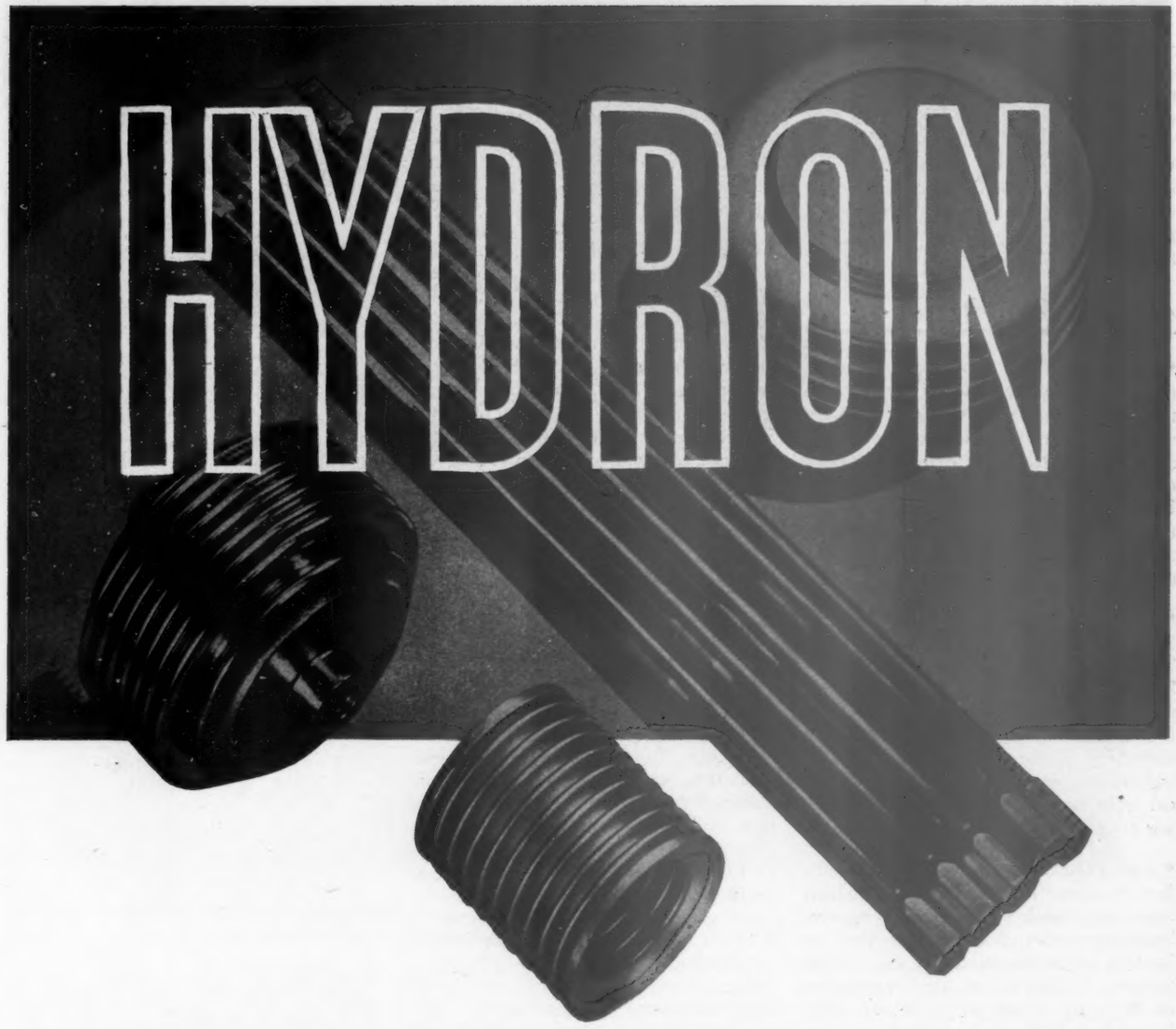
• *A Civil Air Patrol seaplane base* on the New York City water front might be useful for saving some of that time "that is short." Executive hours could be saved by the hundreds.

## Watch Your Weather

Absence of frequent weather reports for the private pilot during the present war emergency makes it imperative that he recognize the possibility and probability of severe atmospheric changes that take place during the late spring and early summer. The suddenness and variety of these changes can not be too highly stressed as they have been responsible for a number of fatal and near-fatal accidents in the past.

Although the most severe changes, which usually take place in March and April are past, one may expect continued changes through May and June that will bear watching.

Cyclones which are a great source of danger to aircraft both in the air and on the ground usually have their inception as a wave on a front parallel to the Continental Divide, with the crest frequently




## EXTRUDED TUBING — METALLIC BELLOWS

For aircraft radiators, oil coolers, inter-coolers, and heat interchangers; for liquid-cooled and air-cooled motors.

For all types of temperature and pressure control devices for aircraft engine cooling systems, carburetors and super-chargers.

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over Colorado. They usually follow a slow course toward the Panhandle and then swing east-southeastward. Central pressure at this stage is very often below 998 lbs, or 29.50 in. The cyclone path then swings toward the northeast, finally exiting between Lake Superior and the Gulf of St. Lawrence.

Paul A. Gareau of the CAB Safety Bureau writes in a safety bulletin: "The fresh surface winds which result from the steep gradient (around the cyclone) are of immediate interest to the operator and pilot of light and medium aircraft. . . . The violence of the shifting winds associated with the entering edge of cold air for a considerable distance (along the cold front) from the cyclone's center may and occasionally does, reach proportions endangering even heavier transports. The astounding increases in velocity which occur in the upper winds along the warm front surface are of particular importance to instrument flight. Experience has shown that unless allowance is made for the sometimes misleading pilot-balloon observations (due to cloudiness and precipitation and radio static conditions) the flight crew or pilot may encounter bewildering drift angles, unbelievable gains or losses in elapsed time between fixes. . . ."

The inception of thunder storms during this period are usually rapid with icing and turbulence frequently severe. A feature of utmost importance to the preparation of flight through areas affected by the cold front is the occurence of violent storms far *ahead* of the front's surface position. The development of this condition is often too rapid to permit full cognizance of severity and extent until the line of storms is full-fledged.

High moisture content of the atmosphere over the southern regions sometimes causes icing conditions to take place in carburetors resulting in loss of power and possible forced landings. Judicious use of carburetor heat controls will usually prevent such a condition from occuring.

With the war effort demanding more and more planes and pilots, help "Keep 'em Flying" by watching *your* weather!

## Strohmeier Instructs Cadets

William D. (Bill) Strohmeier, well known pilot, aviation writer and Piper sales promotion manager has been named Flight Commander at the Hawthorne School of Aeronautics, Orangeburg, S. C., where he will do his "bit" by training Army cadets. He is on leave of absence from Piper for the duration. A frequent contributor to AVIATION in the past, Bill will continue to present his articles on light plane operation and training activities.

NYA AIDS AIRCRAFT PRODUCTION

*7000 youths trained by the National Youth Administration have been employed in the aircraft industry in the past twelve months. Trained in NYA workshops that were set up with the technical assistance of production men from the industry, these young people received basic training in the mechanical operations essential to war production and were able to step into factory work with little time lost for "breaking in." An additional 130,000 trainees of which 7,000 are girls, are receiving basic training in various mechanical trades to fit them for work in the expanding war effort. Above photo shows NYA trained men checking the installation of a Pratt & Whitney Twin Wasp at the Glenn L. Martin plant in Baltimore.*

*William D. Strohmeier*

## Civil Operation And Training

### ON PATROL . . .

"*MEN AT WORK* is the key note for CAP! Although a number of CAP units are doing wartime assignments, the job of the rest is to train and practice. The hard lessons of discipline, coordination, specialized skill and military secrecy must be practiced again and again until every man knows them. Airports must be kept open. CAA regulations must be strictly adhered to. Infractions will place all civil aviation in jeopardy. Units must cooperate with the civil defense agencies in their areas wherever the use of planes or the experience of airmen can help." . . . From Earle L. Johnson's communication to all Wing and Group Commanders.

• *Henceforth, all CAP flight missions* must be under formal operations orders signed by the Operations Officer of the unit of his deputy. CAP insurance protection, credit toward training requirements, and reimbursement of expenses will be denied on flights not so authorized. Operations orders on search missions are not a permit for hedge-hopping and unnecessary aerobatics. Although certain missions, including pick-up message training, will require low flying, such flying must be cleared with CAA inspectors and airport managers.

• *Although New York and Ohio* have the highest number of CAP registrants, 2,689 and 2,018 respectively, Delaware leads with the highest percentage of her pilot population, it being 87.7 percent. New Hampshire is second with 73 percent. By way of comparison, New York has 36.4 percent of her pilots signed up.

• *Consolidation* of the Georgia State Guard Air Force, comprising 200 pilots, with the CAP has been announced by Wing Commander Nunnally. Act will avoid duplication of personnel and will enhance quick training of non-military members.

• *Weather information,* a military secret, is being made available to all active CAP personnel on the same basis as is accorded airline personnel. Weather stations receive current lists of all local CAP members to whom data can be given.

# SAVED . . . TO FIGHT AGAIN

Out on the fighting front, gunfire and crash landings take a heavy toll of propeller blades. 2½ years of wartime experience have proved that successful repairs can be made on over 80% of all Hamilton Standard blades damaged in combat.

This adaptability to repair of Hamilton Standard duralumin-type blades means a vital saving in time and materials.

**HAMILTON STANDARD PROPELLERS**

EAST HARTFORD, CONNECTICUT

ONE OF THE THREE DIVISIONS OF UNITED AIRCRAFT CORPORATION

The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington C. B. F. MACAULEY, New York RANDOLPH HAWTHORNE, New York E. EUGENE MILLER, New York

## Air Force, in History's Longest Air Raid Swamps 8 Jap Ships, Loses Only One Plane

The American Air Force's 4,000-mile raid on the Jap-held Philippines, from Darwin, Australia, was the longest military air operation in history thus far. That fact, added to its success in knocking out eight ships and in damaging other enemy forces, plus the loss of only one airplane, makes it an epoch in the annals of air war.

This raid is a preview of Allied aerial action in the Far East. As we go to press, heartening news is received of the first U. S. bombings of Japan proper, but no details are available yet. But we can rest assured that as more American bombers pour into the Southwest Pacific Islands, enemy bases, industrial areas, and ships at sea will be attacked with increasing intensity and frequency. But it will be hard going so long as the Japanese can build enough planes to fight back. The American authorities say their planes and their pilots are good.

The Darwin-Philippine raid was ordered by Gen. MacArthur, with the concurrence of Lt.-Gen. George Brett, Allied air commander for the Southwest Pacific, and Maj.-Gen. Rush Lincoln, chief of the Army Air Force in Australia. Brig.-Gen. Ralph Royce was the task force commander, but his plane was grounded by engine trouble at some landing point, and the attack was conducted by Lt.-Col. J. H. Davies and Capt. Frank P. Bostrom.

The force consisted of 13 planes: three Boeing B-17's and 10 North American B-25's. Range of the B-25 is less than 2,000 miles, so it is known that the force landed on ground held by the Allies. The B-17, however, could have made the 4,000-mile round trip. The one plane lost appears to have been a forced landing, as the entire crew was rescued.

Longest raids before this one were made by the British on North Italy. The Royce raid has one sinister implication: if we can do it, so can Germany—if she can gain a foothold within some 2,000 miles of these shores.

BRIG. GEN. RALPH ROYCE
Who volunteered for and participated in the Army Air Forces bombing mission against Japanese bases in the Philippines.

## Urges Materials For Plane Producers

Visiting the Glenn L. Martin Co. aircraft plant at Baltimore, members of the Senate committee investigating the national defense program expressed satisfaction with "determination and progressiveness of the airplane factories" and the spirit of workers. Senator Harry S. Truman, chairman of the committee stated: "—we are most encouraged by the progress we have found in the aircraft industry."

Discussing shortages in materials at aircraft plants, Senator Harley M. Kilgore declared: "The problem goes back to the basic materials. We must find means of gearing the production of these materials to the needs of the aircraft manufacturers." Representative Harold H. Burton and Merrill C. Meigs, director of aircraft production, WPB, accompanied the senators.

## Rickenbacker is Back

The war will last a minimum of five years, says Col. Eddie Rickenbacker, and we will need at least 300,000 pilots. Rickenbacker, who has flown 15,000 miles throughout the United States visiting combat units at the request of Gen. H. H. Arnold, Chief of the U. S. Army Air Forces, estimates that about 100,000 of the pilots would be needed as instructors. With a possibility of the war lasting ten years, he adds there is no need for a feeling of inferiority because man for man, and plane for plane, the U. S. has the greatest aerial fighting machines in the world today.

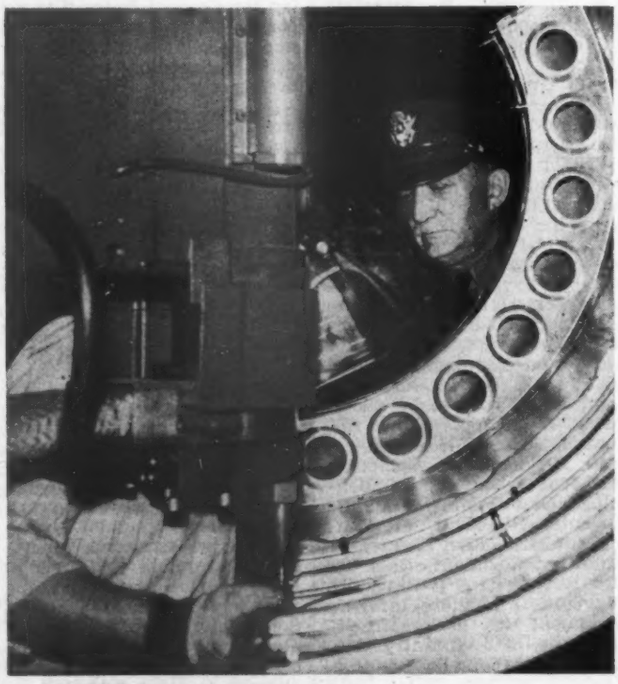
## Calif. Plane Builders Form War Council

Organization of Aircraft War Production Council, Inc., was announced early last month, with a membership of Consolidated, Douglas, Lockheed, North American, Northrop, Ryan, Vega, and Vultee.

The council will coordinate and extend the present practice of exchanging information and pooling facilities. The presidents of the member companies wired WPB Chairman Donald Nelson offering their joint services "as a regional planning coordinating and advisory committee. . ."

The council's headquarters is at 7046 Hollywood Boulevard, Los Angeles, in charge of John C. Lee.

When questioned about this development, the Aeronautical Chamber of Commerce, Washington, indicated it had not been advised or consulted. It was noted that Boeing, on the Pacific Coast, and associated with Douglas and Vega in the production of bombers, was not named a member of the council.



KNUDSEN TOURS AIRCRAFT PLANTS
Lieut.-Gen. William S. Knudsen, director of production for the War Department, gets a close-up on production at a Curtiss-Wright airplane plant during a recent tour of the Middle West. He told workers: "The only way we can win quickly is for you fellows to give your support to boys who are out there fighting for you. . . . Give us all you've got!"

# NATIONAL AVIATION

## U. S. Airplane Output Alone Equals Axis We'll Soon Control Air in Most Places

American airplane production alone is now equal to and soon will far exceed the output of the three Axis powers combined. The Axis cannot expand very much.

The production of England, Russia, Canada, Australia, China and South America all adds up to a favorable balance over and above that of the Axis.

American output exceeds Germany's rate by about 35 percent, and our rate is between six and ten times that of Japan. Italy's production is probably about the same as that of Japan. We are exceeding the production rates of both Britain and Russia. The Allies can soon control the air in most places.

When you consider that more and more of our materials and man-hours are going into heavy bombers, you realize that our unit output is even better than it looks to the casual eye. The shift to bombers makes all the more difficult the task of meeting the President's schedule of 60,000 units this year.

We learn very little about numbers produced by different companies these days, but the War Department did permit Boeing to say its output of B-17's has doubled since Pearl Harbor, is far ahead of schedule. It would be even better if more materials were available.

Nelson of WPB says that automobile plant conversion, which is extensively devoted to airplanes, is beyond expectations. He cites machine tool shortages and difficulties in expanding plant as two of the chief bottlenecks.

## Ground Force Creates Airborne Command

Creation of an Airborne Command of the Army Ground Forces, is announced by the War Department, to be commanded by Col. William Lee, Infantry. Headquarters for the command will be established at Ft. Bragg, North Carolina. Five units of the Army Ground Forces already have been assigned to this command with further expansion planned.

Glider units, one of the most important elements of the command, will be made available from the Air Forces for special training. Immediate concerns of the command will be formulation and development of tactical and training doctrine, development and standardization of material and equipment, and changes in the tables of organization and basic allowance. It comprises the following units: Headquarters and Headquarters Company, Airborne Command, Ft. Benning, Ga.; 502nd Parachute Infantry Regiment, Ft. Benning, Ga.; 503rd Parachute Infantry Regiment, (less the 3rd Battalion), Ft. Bragg, N. C.; 504th Parachute Infantry Regiment (to be organized) and the 88th Infantry Airborne Battalion, Ft. Benning, Ga.

These parachute units existed before the creation of the Ground Force. Organization of this command fits the airborne forces into the Ground Force. The Air Force will furnish and fly the planes that carry the paratroops, who are air-transported soldiers trained to descend in chutes and to fight on the ground. The Air Force also will fly the gliders it lends to the Ground Force, to transport troops. So far the Ground Force flies no planes of its own except the small liaison units that go with the artillery to observe fire.

Do not confuse parachute troops with plain airborne troops. The Ground Force is training soldiers to ride in transport planes which land in enemy territory. They even make crash landings if no fields are available. There appears to be no separate command of these troops as yet.

## Trainers Shunt Dural Navy Gets a Timm

Important airplane structural and materials history is being written at a fast clip. Three important trainer plane projects have moved toward non-strategic metals in the last few weeks: North American, Fairchild, and Timm. Read the steel and wood plane story in this issue on page 219. Some observers believe that if aluminum production is too slow there will be more changes to other materials.

Timm Aircraft Corp. has delivered to the Anacostia Naval Air Station at Washington, its first experimental plastic-plywood trainer for performance tests. This two-seater monoplane is made 90 percent of wood and plastic glue and 10 percent of metal. The drag of rivet heads is eliminated. It is claimed this construction is stronger than steel. Bullet holes in plastic wood do not "flower", are easily repaired. Woodworkers can be employed in the factory.

## Consolidated Gets Boeing Flight Data

Boeing has turned over to Consolidated its information on the organization and methods of its flight and aerodynamics department, to aid in establishing a similar test program. A seven-man group of flight engineers arrived at Consolidated on a visit, planned through cooperation of the Army Air Forces, to lay groundwork for a new flight test unit.

In the test unit is four groups of scientists: The pilots, with engineering backgrounds; flight engineers who plan the test, compile data in flight and write reports; equipment engineers, who plan the preparation of the planes, the recording instruments and test equipment; and the data analysts, who compute and present the results.

While Boeing is the only aircraft firm to have conducted regularly scheduled, full-crew flights for extended periods above 30,000 feet, it can carry out high-altitude flights on the ground. This is made possible by a stratochamber—a cylinder-shaped laboratory in which the atmosphere can be rarified to the equivalents extreme of altitudes. There is also a "cold-room" to provide the low temperatures of the stratosphere.

Engine installations can be tested under any wind conditions before being placed in new model airplanes. The Boeing outdoor power plant laboratory, designed to take advantage of wind from any direction, saves weeks of testing time.

## Comes Out Fighting

Boeing *Fortresses* are being taken right off the production line and flown without modification or further shakedown tests to actual service three-quarters of the way around the world. This statement was made by Col. John S. Griffith, AAF representative at the Seattle plant. He said that B-17's are credited with the majority of 62 ships sunk or seriously damaged and 50 Japanese fighter planes destroyed by the U. S. Bomber Command in the Far East up to March 1, based on reports made public.

## Kemp Succeeds Smith Who is AAF Colonel

The board of directors of American Airlines, Inc., at a meeting held in New York, elected A. N. Kemp as president of the company to succeed C. R. Smith. Mr. Smith resigned his position as president and director to serve as an officer in the Army Air Forces.

Mr. Kemp has been a member of the board of directors of American since April, 1941. As president of the Pacific Mutual Life Insurance Co., he serves as chairman or director of several other business organizations on the West Coast.

Commissioned a Colonel in the Army, Col. Smith will be a special assistant to Col. Harold L. George, Air Corps, commanding officer of the Ferrying Command.

A. N. KEMP

COL. C. R. SMITH

## New, Bigger, Bombers Unannounced Plants

Without telling the enemy anything new to him, this publication can tell you that the industry is preparing to go into production on new bombers 10 to 20 tons bigger than those now in service. Who will build them, and where, cannot be told.

You don't need to be told by an expert that when Japan's shipping is stopped, Japan will be stopped. Action has shown that ships can be hit profitably often with bombs dropped from level flight, so high as be to be out of reach of effective attack. That means even bigger planes, with longer range, if the war goes on.

Meanwhile we are providing production of plenty of torpedo and dive bomber planes, along with all types for ourselves and the Allies.

New airplane factories are going up which you will not hear about for the duration.

## Airship Patrol Grows

Navy's new lighter-than-air base at Elizabeth, N. J., has been put in commission. It cost $6,000,000. Moffett Field, at Sunnyvale, Calif., which has been under the War Department, is now transferred to the Navy, to be used as a base for non-rigid airships, like those on the East Coast. Other lighter-than-air bases are already in operation. Navy has asked Congress for $700,000 to build a prototype non-rigid ship, about 50 percent larger than those now in use, and to have much longer range. Interior Department is planning to double the current production of helium in 1943.

Back of all this lighter-than-air activity is the fact that the United States is so far from enemy airplanes that is can patrol is coasts in gas bags. Airships cannot be used at all within range of enemy planes. The writer heard Dr. Hugo Eckener say that an airship could not get off the ground in Europe.

Airships can float about for days on one fueling; they can stop and look or take pictures; they can shut off their engines and drift, quiet as a soaring bird.

## Luscombe Taken Over By Treasury

Leo T. Crowley, Alien Property Custodian of the Treasury Department has taken over control of the Luscombe Airplane Corporation at West Trenton, N. J., and plans have been announced for enlargement of the plant and conversion of facilities to production of naval airplane parts. Mr. Crowley has assumed the trusteeship of the holdings of Leopold H. Klotz, the majority stockholder. Last February, the Treasury Department impounded the books and investigated the company. At the time Mr. Klotz was referred to as "a friendly alien". He was born in the principality of Lichenstein.

Christened "Lucky Seven", this "Thunderbolt" was presented to the U. S. Army Air Forces by the workers of Republic Aircraft Corp. Arthur Strickland, subassembly worker, points out insignia to Robert A. Lovett, Assistant Secretary of War for Air, who accepted the plane.

## CPTP Has 3518 Planes

A fleet of 3,518 training planes, valued at $12,000,000 is in use by contractors at more than 700 training centers in the Civil Pilot Training Program. Planes are property of contractors who are giving CAA courses, and represent purchases of new planes since the start of the program in 1939.

About 2,621 elementary planes of eleven different makes are in use. The least expensive, these planes cost about $1,700 each, with tandem seating and of the light plane type; secondary instruction planes are higher powered, cost about $8,000 and are open-type planes; for cross-country and instructors' courses, closed cabin planes of four and five seating capacity are used, and cost $10,000 to $20,000.

Investment of contractors in planes is but a part of the total; many have bought and equipped fields, constructed hangars, school buildings, overhaul and repair stations and other equipment for teaching both ground school and flying.

## Data on 50 Enemy Planes Is Published

Specifications and performance figures, in most cases quite complete, of 50 types of German, Japanese, and Italian combat planes have been made public by the Army Air Force and the British Air Ministry.

Majority of the figures have been known for some time. Of 31 Japanese combat types listed, nine are Army and Navy fighters. These are comparatively and light and low in horsepower—650 to 850. And they carry 7.7 mm. machine guns, approximately equal to our .30 caliber, with now and then a 20 mm. cannon.

The report does not show any Japanese twin-engine fighter ship. Hardly any Jap fighters carry armor.

Only one four-engine Japanese plane is noted; that is the Awanishi T97 flying boat, with 900 hp aircooled engines, and a range of 1,500 miles with a 3,500 lb. bomb load capacity. It appears to have been designed on the Sikorsky S-42 flying boat.

The famous German Focke-Wulf 200K, a 24-ton long-range bomber driven by four 850 hp. engines, has a range of only 2,400 mi. and a bomb load capacity of only 3,300 lb.

## Ontario Crash Report

The Civil Aeronautics Board reports, after investigation, that it does not have sufficient information to determine the cause of American Airlines crash at St. Thomas, Ontario, October 30, 1941, killing 17 passengers and three crew members. The airplane and its trip were normal until, at the scene of the accident, it made about four circles, diminishing from a diameter of 1½ miles. Near the ground it recovered from the spiral, zoomed up 200 to 500 ft., probably stalled, crashed, and burned. The engines functioned normally to the last, and the controls showed no sign of failure, although this could not be determined with certainty.

## Airlines Charter 85 Planes to Air Force To Be Serviced and Flown on Civil Airways

Again the country's airline system is rendering important service to the Army. Voluntarily the operators have turned over to the Air Force about 25 percent or about 85 of their total 340 transport planes.

These 85 planes will fly on the civil airway system, and will be maintained and piloted by the regular crews of the operators. They will make use of civil airway flight aids, terminal facilities, weather reports etc., just as the regular schedule trips do. But presumably, they will take short-cuts when weather permits, and will terminate some trips at air bases.

Air Force insignia are being painted on the planes as they go into Air Force service. They operate under contract with the Army, and are paid an equitable "charter" rate. No civilian passengers or cargo are carried in the Air Force planes. All maximum load, minimum ceiling and other regulations of the CAA and CAB are off, so far as these militarized planes are concerned.

This arrangement does not actually take away 25 percent of the transport system's carrying capacity, as first thought indicates. The airlines are already carrying a large volume of military personnel and cargo. Much military traffic, formerly distributed over all trips of the system, will be carried by the Air Force charter trips. Thus, the regular civilian traffic of the lines will have about as much acommodation as it has had in recent months. Persons who need air transit should in all cases try to get it; the lines have been flying many empty seats because the public thought military priority had taken them all.

Army and Administration are well pleased with airline cooperation. Even more planes may be called for. But the system is creating for itself a good possibility of keeping its identity as a private business.

# WHEN PROMPT DELIVERY COUNTS SO MUCH

NOW, when your products are so urgently needed, you can profit by the ready availability of the Torrington Needle Bearing. As a result of Torrington's expansion program, Needle Bearings in standard sizes and types can be *promptly delivered on all priority orders!*

You can benefit, too, by the Needle Bearing's other features—features that simplify your designs and speed your production processes. Consider these advantages of the Needle Bearing—and see how *every* one of them fills a wartime need.

**IT IS EASY TO INSTALL.** Built as a single compact unit, the bearing is simply pressed into place in the housing—a quick operation ideally suited to high-speed production line methods.

**IT CONSERVES OTHER MATERIALS** on which you may be encountering delivery problems. Because of the Needle Bearing's small outside diameter, you can reduce the size of your housings, and hence the amount of material required.

**IT ELIMINATES EXTRA PARTS AND ASSEMBLY STEPS.** No retaining rings, washers, or end plates are needed to hold the bearing in place—and in most applications, no special lubricating equipment need be provided.

**AND IN PRODUCT PERFORMANCE,** the Needle Bearing offers the advantages of long life, high load capacity, low power consumption, minimum need of service attention.

Let a Torrington engineer show you how these features—demonstrated in thousands of peacetime applications—can be incorporated in your wartime designs. For further details, write, wire, or phone for Catalog No. 114.

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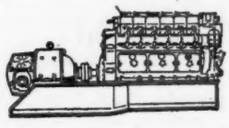
*Established 1866*
TORRINGTON, CONN., U. S. A.
*Makers of Needle and Ball Bearings*
New York Boston Philadelphia Detroit Cleveland Seattle
Chicago Los Angeles San Francisco Toronto London, England

LET'S GO! U.S.A. KEEP 'EM FLYING

TORRINGTON NEEDLE BEARING

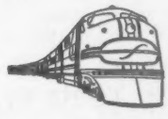
**LONG SERVICE LIFE**



High load capacity and efficient lubrication of the Torrington Needle Bearing result in long service life on the valve rocker arms of Model 36 Diesels built by Fairbanks, Morse & Co. Bearings reduce the need of replacements and of other service attention.

FAIRBANKS, MORSE

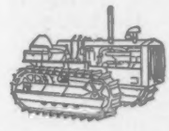
**HIGH EFFICIENCY**



Efficiency and dependability of operation are essential in railroad auxiliary equipment. Safety Car Heating & Lighting Co., Inc., obtains these advantages by using Torrington Needle Bearings on automatic control valves of its Carrier-Safety air conditioning systems.

SAFETY CAR

**EFFECTIVE LUBRICATION**



Because the Needle Bearing's outer race forms a reservoir holding ample quantities of lubricant, the need for service attention is reduced to a minimum. Caterpillar Tractor Co. profits by this feature in its famous line of "Caterpillar" Diesel Tractors.

CATERPILLAR TRACTOR

## CPTP Doubles Program

The entire pilot training facilities of the Civil Aeronautics Administration soon will be devoted to the war program under a plan worked out with the Army Air Forces. First priority in CAA training will go to students who can meet requirements of the Air Forces for appointment as cadets, and who are members of the Air Section of the Enlisted Reserve.

Further training will be limited to students unable to meet requirements for appointment as cadets, but who are qualified to train for CAA flying instructors' licenses. They must agree in writing to devote their future efforts to serve the national interests in aviation.

The CAA is greatly expanding its facilities. The present capacity of 25,000 students per year in elementary pilot training will be raised to 45,000 and in the secondary course from 10,000 to 30,000—more than doubling its program.

Training will also be provided for ground technicians. A new activity of the CAA, this course will provide for about 31,000 students annually. Applicants must be able to meet the requirements for entrance to the Air Corps Technical Schools, and must be members of the Air Section of the Enlisted Reserve.

According to Robert H. Hinckley, assistant secretary of commerce for air, a late start on the CPTP necessitated beginning training courses at the college level. The rudiments of aviation should begin, he says, in the elementary and secondary schools. It should be integrated into the curriculum from the bottom up. All children are interested in aviation, and more than three million are now building and flying model airplanes, largely out of school.

An Aviation Education Research Project has been established at Columbia University, under the auspices of the CAA, to determine what aeronautical studies are necessary for the preparation of young people for flight training. It will also provide teachers with manuals for classroom use, texts, maps and other materials.

The plan will provide an additional reservoir of manpower for the Army's air expansion program, which visualizes an air force of 1,000,000 men by the end of 1942.

By September of this year, it is hoped that plans and materials will be ready for all schools that wish to institute the program.

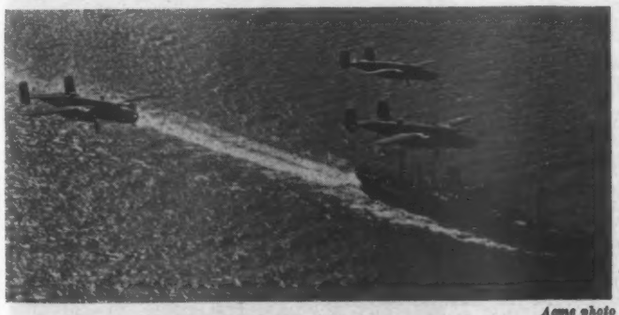
## Kansas City to Get Second Airport

Kansas City's campaign to complete a second major municipal airport, as an inland war industries site, was stepped up with the passage of a million-dollar city bond issue. Construction is started at a 751-acre site.

A large portion of the fund will be offered to the federal government as a contribution for additional federal works projects at the airport. The War and Navy Departments, along with the SPB and aircraft manufacturers, have been advised that the airport is available for new aircraft plants and industries.

## Buried Alive

Abandoned British mines are being walled up, finished, and fitted as aircraft parts plants, bomb-proof and with all the comforts of ordinary factories. Some of these underground plants are in operation, and more are being constructed. The danger of bombing in this country is not great enough to justify the cost of subterranean buildings. Engineers of the CAA say that such buildings are extremely expensive. (See British Underground Factories, Page 76.)



*Acme photo*

ON ATLANTIC SUB PATROL

**A formation of North American B-25 bombers of the First Air Force flies low over friendly merchant vessel off the Atlantic Coast. Army and Navy air units engage in ceaseless patrol over the area and have sunk an unannounced number of submarines.**

## THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

**After long deliberation** over many candidates, our judges have given the Stubblefield award to Senator George of Georgia, for discovering that the airlines have only 350 airplanes and for demanding to know of the Civil Aeronautics Board how come they haven't got more.

**All over the world** aviation people are working devotedly, sometimes forgotten. Hawaiian Airlines is one of these. A letter to this writer, in reply to a query, says "Hawaii is under martial law. I can say that our planes and all facilities are doing a job in this theater of war." Send them an orchid, Miss Jones.

**Stranger than fiction** is the fact that Alaskan's themselves were indifferent to Northwest Airlines application for a short-cut route from Twin-Cities to Alaska. When Alaskans go to town they go to Seattle, Portland, San Francisco; the East Coast is passe. They love Pan American. But Alaskans here do admit that the line will go through some day, and bring Easterners on vacation with money. Meanwhile, Northwest seemed to be getting an Alaska route sponsored by the Army.

**So stingy** was this country with its pre-war Army, and so dead on its bridge tables was the unwanted Army, that it didn't even find out where some very strategic aviation facilities are in foreign countries. Now it wants to know, and is burning the midnight kilowatts and aspirin. We will name a couple of these places for you—in our memoirs.

**Air publicity men** are having a tough time. They don't dare tell about their profits, if any, because Morgenthau will read it. They fear to mention service to civilians, lest they be branded BASU for business as usual. Even cheese-cake pictures are bad; they suggest fiddling while powder burns. It's a one-angle job now, and the angle is military.

**Are you worried** about air attacks on these shores? Our high command expects an attack from day to day. But, whether it came from ship-based or long-range land-based forces, Jap or German, it would be about as effective militarily, as the bite of a cootie.

**Boeing-Douglas-Vega** technical committee is turning out to be a workhouse. All mechanical and design and materials problems of any one of the triumvirate are turned over to the committee, so that all three hear the answers at once instead of one at a time.

**Have you realized** that the only war equipment for which critical shipping space does not have to be provided is long-range bombers? These bombers not only carry themselves to the firing line, they carry supplies and men as well.

**Jet propulsion motors** are reported in production and coming to the German fronts for action. They are used only as boosters for takeoff. You can feel assured that our own excellent developments in jet power are being carried forward.

## Brazil Builds Engines

Wright Aeronautical Corporation has signed a contract with Brazil under which that country will have its first aircraft engine factory. The company will be called Fabrica Nacional de Motores. It will turn out seven- and nine-cylinder engines of 235 to 450 hp. These will be sent back to the U. S. for use in trainers, blimps, and medium tanks.

## Flight Strips

A national system of roadside flight strips is being started with $10,000,000 appropriated in a bill just signed by the President. These runways will be convenient to automotive transportation. They will provide many dispersion points for combat airplanes should hostilities ever come to this soil. After the war, the flight strips will be convenient ports for private flying. They will be built parallel with prevailing winds. Some of them will be as much as 8,000 ft. long. Four-lane highways, if unobstructed by poles, wires, trees, make good emergency runways, and they would be cleared of traffic and used in emergency.

A corner of the Loan Aeronautical Exhibition of the Institute of the Aeronautical Sciences at the University Club, New York. Center: The Musick Trophy. Right: The Gordon Bennett Balloon Trophy.

## Bill Redding Becomes Manager of NAA

For the second time in the past year, National Headquarters of NAA has had to make changes because of a manager being called to active Army duty. Kendall K. Hoyt, formerly publicity director became manager when last May, Col. G. deFreest Larner, general manager was sent to London as an air attache. Hoyt has in turn been called to service as a lieutenant in the Air Forces.

William P. Redding, treasurer, has been elected by the board of directors to the new post of executive vice-president with managerial duties. Lt. Hoyt has been acting as intelligence officer of the CAP and his assignment to the CAP on a military status was requested by Maj.-Gen. Curry.

## CALLING NAMES

**Earl Herring** has been elected president of Kinner Motors, Inc. He will continue as gen. mgr. of the company.

**Charles Maxwell Kearns,** project engineer of Hamilton Standard Propellers received the coveted Longstreth Medal awarded by The Franklin Institute.

**David Beecroft,** Bendix Aviation Corp., is elected treasurer of S.A.E. **Peter Altman** of Vultee is elected a vice pres. representing aircraft activity, and **C. F. Bachle** of Continental Aviation & Engineering Corp. is elected a vice pres. representing aircraft-engine activity.

**D. J. Rogers** is promoted to special assistant to President W. A. Patterson of United Air Lines. **Dr. Arthur C. Ladd** is in charge of the line's new medical branch at San Francisco, under Col. A. D. Tuttle. **Robert V. Laustrup** becomes superintendent of stewardesses for the western division.

**A. R. Glancy,** formerly chief of ordnance div. of OPM, is appointed an expert consultant to the Secretary of War and detailed as a special assistant to the Under Secretary of War.

**Orn O. Johnson,** general manager of Iceland Airways Ltd., Reykjavik, is visiting this country.

**Wallace N. Guthrie** is elected executive vice pres. and appointed gen. manager of Cuno Engineering Corp.

**Vincent Bendix** is reelected president of Bendix Aviation Corp.; **Charles Marcus, D. O. Thomas, E. R. Palmer, William L. McGrath, R. P. Lansing,** and **M. P. Ferguson,** vice presidents; **W. H. Houghton,** comptroller; **H. A. Gossner,** secretary.

**Joseph J. George,** Eastern Air Lines' chief meteorologist, is lecturing at the Institute of Meteorology, University of Chicago.

**Joseph Farkas,** formerly superintendent of aircraft div. of Maury Corp. of America, joins Emerson Electric Mfg. Co. as superintendent of aircraft turret div.

**Albert A. Haniford** joins the sales department of Manning, Maxwell & Moore. **Walter Williams** goes from Chicago territory to the St. Louis territory, formerly covered by **Harold Moore** who has joined the armed forces.

**Earle L. Johnson,** exec. officer of CAP was named national commander by James M. Landis, head of OCD.

**J. C. Shaw** will head engineering work in the Young Radiator Company's enlarged aircraft products division.

**Thomas H. Beck,** editorial director, Collier's was awarded the Frank M. Hawks Memorial Trophy for contribution to aviation during the year. Award is made by N. Y. Post 1 of the American Legion.

**Major H. R. Bazley** is now vice-pres. chg. operations and **Harry R. Stringer** becomes vice-pres. chg. traffic, advertising and public relations for All American Aviation, Inc.

Among promotions announced at Braniff, **Robert J. Smith** becomes exec. vice-pres., **Capt. Ray C. Shrader** is vice-pres. chg. operations, and **Capt. R. W. Pears** is system chief pilot. **Tracy Walsh** will be divisional operations manager at San Antonio, **Jack Brough** becomes flight supt., and **Jack Daugherty** will be supervisor of stations.

**Charles E. Smith** will be Army liaison officer for Aeronca.

**Glenn L. Martin** is New York Advertising Club's "man-of-the-month".

**Edward G. Miller** resigned from Air Associates, Inc. to join staff of Emerson Electric Mfg. Co.

**W. G. (Swede) Golien** has been appointed chief pilot for TWA and **George Rice** becomes western region chief pilot.

**George Cower Wright** is now city traffic manager for American Airlines in Syracuse, and **T. P. Gould** goes to Boston as asst. New England traffic manager.

**James W. Bancker** has retired as director and vice-pres. of the Western Electric Co.

**Robert A. Wickes** was elected sec. and treas. of American Bosch Corp.

**J. D. Van Valkenburgh** is appointed asst. to pres. of Irvington Varnish & Insulator Co.

**Jack S. Hunt** is now general manager of the Embry-Riddle School of Aviation in Miami.

**Fred W. Cederleaf** was appointed plant manager of the two Detroit plants of the Republic Aircraft Products Division.

**J. D. Young** is manager of pump sales and W. J. Wagner becomes asst. to the pres. of the Tuthill Pump Co.

**Perry V. Ogden** is factory mgr. and gen. supt. in the mfg. division of Boeing Aircraft Co.'s Seattle plant.

**Marion P. Crews,** former CAA official, is appointed Dayton representative of Boeing Airplane Co.

**Mrs. Helen Goodrich** is the first woman to join the Ryan plant protection force.

**D. E. Gamble** of Borg & Beck Div., Borg-Warner Corp., is named assistant chief of Heavy Ordnance for the WPB.

**Gordon C. Sleeper,** has been named a member of the executive staff of Republic Aviation Corp. as assistant to the pres.

**Uniloy Accessories Corp.** of Lancaster, N. Y., has changed its name to the Scott Aviation Corp.

**Mrs. Inez Biancett,** of Braniff at Wichita Falls, Tex., is believed to be the only female district traffic manager in the airline business.

**Thomas F. Ryan,** pres., of Mid Continent, resigned to enter military service; J. W. Miller, vice-pres. and gen. mgr., is elected new pres.

**George A. Smith** is elected to the Western Air Lines' board of directors.

**Alan J. Pickering** has been elected asst. treas. of Republic Aviation Corp.

**N. B. Haley,** treas. of UAL is elected vice-pres. of the Airline Finance and Accounting Conference of the Air Transport Assoc.

**C. P. Graddick,** director of UAL's air express-mail-freight department, returned to Chicago headquarters after a month spent in studying air cargo conditions along the Pacific Coast.

**Merle Cartwright** is first American girl to enter Trans-Canada's training school at Winnipeg.

**Wheaton W. Miles** is appointed asst. supt. of maintenance of Northeast Airlines.

**Benjamin M. Smarr** is appointed director of purchases of the Aviation's Corporation's operations staff at the Detroit divisional office.

**Raymond C. Thompson** has joined the engineering department of Aero Insurance Underwriters, New York City.

**S. R. Puffer, Waverly A. Reeves,** and **Dr. C. W. Smith,** have been given the Coffin Award by General Electric for perfecting the turbosupercharger.

**G. M. Williams** is elected director, vice-chairman of the board and member of the executive committee of Vultee.

**Dwight P. Joyce,** vice-pres. of The Glidden Co., is named group commander of the CAP for the Cleveland Division.

**Robinson S. Kersh,** is appointed mgr. of the Houston, Tex., office of Westinghouse.

# *Ten thousand to One . . .*

NEVER before in all history has so much depended on the *man behind the man* behind the gun. His battle lines are production lines; his weapons are the tools of his trade. Quotas be damned; whatever quantities are asked he must strive to exceed. His is the colossal task of changing "too little and too late" to "an abundance and on time."

There is an exaltation in mortal combat that drives men to heroic deeds. Medals of honor and a nation's gratitude justly reward their courage. For every hero so honored there are 10,000 unsung heroes in the battle of production. They are the men and women who toil without the spur of conflict in absolute devotion to freedom's cause. They are the *builders* of victory.

Final triumph will be won by the side that works hardest and produces the most. If all America matches the unrelenting efforts of the aircraft industry there can be no doubt which side that will be. Are your sleeves rolled up? Have you the right to consider yourself one of the ten thousand to one?

Donald W. Douglas

PRESIDENT, DOUGLAS AIRCRAFT CO.

U. S. Army Photo
Douglas Workers

# THE WORLD'S LARGEST BOMBER
## DOUGLAS B-19

# "Gets Hair-Trigger Control"
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Driven by 8000 H.P., this 82-ton giant with a wing spread of 212 feet is the largest warplane ever built. NORMA-HOFFMANN PRECISION BEARINGS are used in its controls, providing rigidity, sensitiveness and instant response.

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*Pledged to all-out aid to America's fighting forces, NORMA-HOFFMANN is devoting all its resources and its 31 years' experience to the production of PRECISION BEARINGS for Army, Navy, and Air Corps units.*

## Designers Use Non-Strategic Materials
## North America Announces Steel Trainer
## Curtiss-Wright Projects Wood Transport

Rather than wait while aluminum output is laboriously increased to meet urgent war requirements, two foremost aircraft manufacturers have completed plans for production from non-strategic materials.

North American Aviation is using a combination of low carbon low alloy steel, and plywood, to reduce aluminum content of its AT-6 trainer 75 percent by weight.

Curtiss-Wright is erecting a plant to build Army transport planes largely of wood, using metal only at points requiring extreme strength.

North American says it may soon announce success in the application of the new materials to combat types, such as the B-25 bomber and the *Mustang* fighter.

These developments are of utmost importance. The drives for maximum aluminum and magnesium output will go on as before, but as N.A.A. says, if this war should drag on in a battle of resources, steel might play the last card in the air. U. S. production of steel is about 90,000,000 tons a year, against Japan's less than 10,000,000 and Germany's 24,000,000 in 1939, which is probably more now.

N.A.A. and Curtiss-Wright appear to be out in front with their wood and steel programs, but other companies are working along similar lines. Fleetwings has built highly successful stainless steel planes which contain a low percentage of strategic alloy metals. Engineering Research Corp., builders of the small *Ercoupe* plane, completed a satisfactory shift to part steel when aluminum was taken from "non-essential" plane builders. The Reconstruction Finance Corporation, recently designed a steel cargo plane, hoping to manufacture it for use in South America. Steel construction is not new; many have contribued. Wood has been used from the beginning of airfoil experimentation.

The N.A.A. AT-6 will have steel wings, wing center sections, wing tips, vertical stabilizers, rudders, elevators, flaps, allerons, and various pieces of cowling and fairing. Wood and steel parts are shown in the picture on this page.

For each 4,000-pound AT-6, 1,246 pounds of aluminum alloy will be saved for other defense production; 1,000 such trainers would save 623 tons or enough for 150 medium bombers.

The low alloy steel contains less than two percent of strategic alloys, as contrasted with more than 25 percent strategic alloy in stainless steel, says N.A.A.

Exterior surface of steel wings and fuselage will be as smooth as glass because rivet heads will be eliminated—sections will be joined by spot-welding. Wood assemblies will be glued. Aluminum alloy commonly used in airplane is so difficult to weld that it is mostly riveted. This is expensive and creates drag in the air.

The steel and wood AT-6 will be about 150 lb. heavier than the dural model, but the AT-6 permissible design overload is 350 lb. Engineers believe they can put the steel model down to dural weight.

North American's steel and wood trainer reduces aluminum content of the AT-6 75 percent by weight. North American also is experimenting with application of similar materials to combat types.

*Globe photo*

PRESSURE CABIN FOR STRATO' FLYING

Pressurized cabin for the Douglas C-54 will enable this giant 4-engine transport to carry troops above effective altitudes of enemy fighters.

## Airplane Output Increases 50% Since Dec. 7
## Manufacturers Are Short of Parts, Supplies

Washington (AVIATION Bureau)—A 50 percent increase in airplane production since Pearl Sunday was announced in late March by Donald Nelson, WPB chief. This was not as good as it looked to some laymen because it happened that the month on which the increase percentage was figured had been off a bit.

But it was as good as most optimistic aircraftmen expected. The rising production curve looked to those who know the figures as if we will make the year end high point necessary to average the 5,000 a month necessary to total the 60,000 called for by FDR.

A look-around convinced the Aero Chamber that slowdown stories are mostly inspired by subverters. Trouble is not with strikes, or slowdowns, or skill shortages. Production is slowed by lack of materials and parts, including extrusions and hundreds of machined items, and forgings. Congressional investigators say that OPM and SPAB rushed aircraft plant capacity effectively but failed to speed the vendor and sub-contract elements to match. This matter is under study at WPB.

One big plant told AVIATION it is seriously short of heavy forgings and is trying to remedy the trouble by substituting castings where possible.

Col. John H. Jouett, president of the Aero Chamber, says the industry is designing and producing more than a score of new and refined combat planes.

Even with the industry slowed by shortages, several individual manufacturers are far ahead of the schedules laid down for them.

## FDR Asks $18 Billion For 31,000 Planes

Washington (AVIATION Bureau)—At the President's request, Congress has passed an appropriation bill for $18,301,961,345 for the purchase of 31,070 additional Army airplanes.

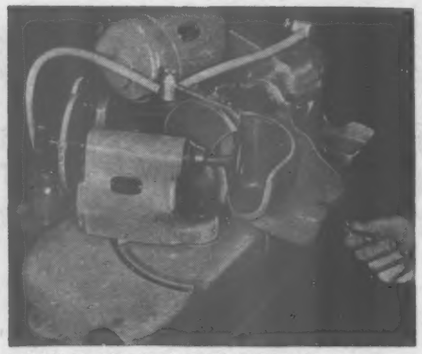
The War Production Board recently added up appropriations for military planes since June, 1940, and got a total of $26,804,000,000 which, added to the 17½ billion, is over 44 billion dollars, more than the national debt was before the war. The board estimates that about 20 percent of the overall war bill is for airplanes.

Mr. Roosevelt's request for 17½ billion is to bring orders for 1942-43 up to 124,500 planes. He said he would ask for another appropriation about the time you read this, to cover an additional 23,500 planes, or a total of 148,000. This will leave him 37,000 short of financing his goal of 185,000 for this year and next. It is supposed this balance will be ordered for the Navy.

It would not surprise Congress or the industry if the

**BLACK & DECKER LECTRO-SHEAR** fabricating plane cowling. This lightweight, speedy tool quickly and accurately snips straight, curved or irregular cuts in sheet metal.

**VIBRO-CENTRIC** Valve Seat Grinder reconditions aircraft valve seats in seconds. Here's a Black & Decker unit for putting on a smooth finish as accurate as the original factory job.



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**PORTABLE ELECTRIC TOOLS**

President, probably upon request of the Army and Navy, should raise his 1942-43 goal to something above 185,000 planes, and ask for still more billions to finance them. This he will probably do if and when he sees that it possible for the manufacturers to exceed his last request.

The United States is turning out the quality and quantity now in excess of any country in the world, but this output is being parceled out to so many different spots that it doesn't yet show up big anywhere. Army officers say that day will not be long coming.

## Light Metal Program

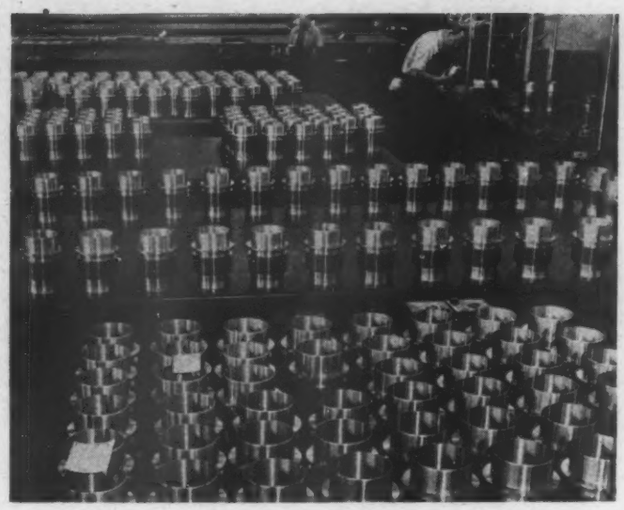
The schedule of aluminum production has been raised to aim at an eventual annual output of over 2,500,000,000 pounds.

William L. Batt, WPB director of materials, explained that it may be broken down into four parts: (1) present facilities are producing at the rate of 850,000,000 pounds; (2) the "first expansion program" facilities now under construction adds 640,000,000 pounds, (3) imports from Canada's Aluminum Company of America will reach a rate of 450,000,000 pounds in 1943, (4) the present program just adopted and approved by Nelson will add an additional 640,000,000 pounds.

Actually, the new program will have no effect on this year's aluminum output, which long ago was estimated at about one billion pounds, and still is.

The magnesium production schedule has been pushed up from facilities to produce 400,000,000 pounds a year, only part of it now in operation, to an eventual 725,000,000 pounds. In 1941 we produced 33,000,000 pounds, and the present rate of course is somewhat higher than that.

Defense Plant Corporation has contracted with six U. S. companies to produce magnesium at the rate of 157,000,000 pounds per year, using ferro-silicon processes; all but one using gas heat rather than electric power.



Finished cylinder barrels awaiting next production operation at General Motors' Buick Division, now building Pratt & Whitney engines for warplanes under license agreement with United Aircraft Corp.

## War Powers Act

Drastic extension of administration power is conferred in the 15 provisions of the Second War Powers Act, aimed at speeding all war production.

Conferring sweeping priorities and requisitions authority on the President, the measure subjects all contracts to his authority, authorizes him to require acceptance and performance of contracts and to allocate production facilities. Limited only by the so-called Hancock amendment the bill empowers government to requisition private property.

The Navy is authorized to negotiate contracts for ships or aircraft without competitive bidding.

Violators are subject to fines of $10,000, one year imprisonment or both.

## ASSEMBLY LINES . . . By Dorsey Adams

**Precision flight instrument** and optical aircraft equipment production by Square D Company will increase through additional plant facilities. With its Kollsman division the company is said to be one of the three largest makers of aircraft instruments in the U. S. The additional facilities, built by the Defense Plant Corporation, will be leased to Square D Company with an option to purchase. Because of the high number and complexity of precision machines, many of them specially built, the company is buying this equipment with its own funds. In departments requiring highest precision work, particularly in the optical department where critical measurements are made in millionths of an inch, complete air-conditioning will be installed to make an even temperature of 68 deg. F.

**Buick-built bomber engines** are being produced at the rate originally planned for next December, with production nine months ahead of schedule. Trainload shipments are being made to plant manufacturers. According to present production, the 1942 output will be packed into the first six months of this year and by July the company will have built more engines than originally scheduled through the first quarter of 1943.

**Navy's "E" Award** goes to Bell Aircraft Corporation and Pratt & Whitney Aircraft (see story on page 133) for outstanding performance in fulfilling Navy contracts. The award remains effective for six months and if the companies maintain the high production schedules a star will be added to the E on the pennant.

**Production of bomber sections** is being stepped up now that the Fisher Body Division of General Motors has completed an expansion in bomber production facilities. Facilities now available are sufficient for maximum scheduled output. Shipment of parts and sections scheduled for March was completed the first week of the month.

**The moving assembly line** was recently put in use by Consolidated Aircraft turning out Army's four-engine B-24, which the British call the *Liberator*. It is to be extended to the production of other types of planes built by this company—the Navy's famed twin-engine PBY *Catalina* flying boat, and the PB2Y, a 30-ton, four-engine patrol bomber with a range of over 5,000 miles.

**A training plane** built voluntarily by the management and employees of the Spartan Aircraft, on a Sunday, was presented as a gift to the U. S. Navy. All work was voluntary.

**A group insurance plan** has been put into operation at Glenn L. Martin. Policies are issued on a salary basis, range in value from $1,000 to $10,000. Instigated by Mr. Martin and worked out with officials of the Connecticut General Life Insurance Co., the program provides comprehensive accident and life insurance for every man and woman at the plant.

**North American Aviation** will award $10,000 in Defense Bonds to its employees for the best suggestions on how to improve production. Bonds range in value up to $1,000.

**Ryan Aeronautical Company's** specialized exhaust manufacturing division has passed an important milestone. Company cannot disclose number, but it establishes the manifold division of the Ryan company as a leading producer of these accessory units. Manifold technicians have been responsible, the company says, for many of the advanced engineering developments which in recent years have kept exhaust system research abreast of engines up to 2,000 hp. Their manifolds have been developed to operate turbo-superchargers.

**Republic Aviation Corporation** presented to Robert A. Lovett, assistant secretary of war for air, a P-47 *Thunderbolt* pursuit plane built with contributions of employees. Materials were contributed by the company and subcontractors.

**Aircraft spruce lumber prices,** established by OPA, are set at October levels. The lumber is used in manufacture of trainer planes. Maximum prices became effective April 1.

**Airplane gliders** are being produced by one trailer manufacturing company as the industry is converted to war production. Three other companies are planning to produce wooden training planes.

**Fourteen million dollars** has been returned to the government through cuts in one of North American Aviation's plants. Improved production methods and more efficient tools allowed for a 33⅓ percent reduction in output costs, says their president. That figure applies to only one plant but costs have been cut in all of them.

# AVIATION ABROAD

## Canadian News

By JAMES MONTAGNES

Canadian Pacific Railway's airlines have added three Boeing twin-engine passenger and freight aircraft to the fleet of approximately 90 airplanes now operated in western and northern Canada, by the various companies CPR bought during the past year. With considerable expansion of air routes in north-western Ontario, northern Manitoba, on the Prairies, and in the coastal, sub-Arctic and Arctic regions, now in contemplation, several additional orders for aircraft will be placed this spring, according to a report of Sir Edward Beatty, CPR president. This supply would be dependent largely upon conditions made somewhat unpredictable by the war, but Sir Edward pointed out many of the company's aircraft would be engaged in military freighting on the northwest defense route and that some priority in this respect might be expected.

In his annual report on March 16, 1942, Sir Edward Beatty stated: "The government has recognized the necessity for the maintenance of these services, and the necessary priorities have been granted for equipment, repair parts and supplies. . . . Investment (by the CPR) in these affiliated companies, including advances for the acquisition of equipment, working capital and other requirements, amounts to approximately $3,400,000. Further steps towards the consolidation of these companies are being taken."

Canada inaugurated a new domestic air mail service between Montreal, Three Rivers and Quebec City on April 15, as part of the expanding operations of the publicly owned Trans-Canada Air Lines. This expanded service on May 1 will give 24 hr. service between St. John's, Newfoundland, and Vancouver. Familiarization flights were made during April on this service. A 4½ hr. flying service from Torbay Airport, St. John's, Newfoundland, will link that country with TCA at Moncton, New Brunswick. According to D. R. MacLaren, TCA superintendent of passenger service, it sometimes took as many as 4½ days to make the rail and steamship trip between Moncton and St. John's. The new service will give passenger, air mail and express service to the Newfoundland-Canada route.

Recently 885 miles of teletype circuits were added to TCA between Toronto and Halifax to service the airline's maritime operations. This makes TCA one of the largest users of private wire services in the country. Between Vancouver and Halifax are strung 4,588 circuit miles, with the longest single circuit of 1,182 miles from Winnipeg to Vancouver.

TCA is now making its own plane seats because manufacturers are busy on war work. All the old features have been retained but TCA designers have lopped 18 lb. off the weight of each, thus reducing the load in each aircraft by 180 lb.

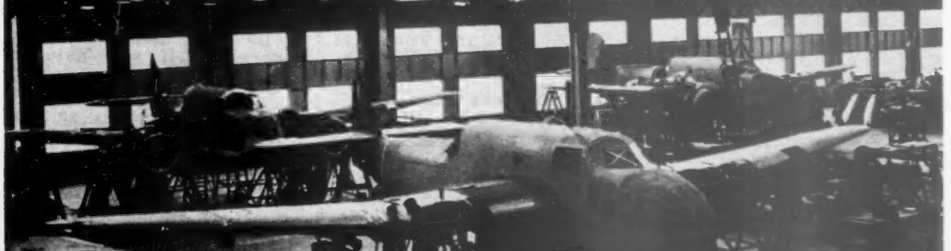
**C. H. "Punch" Dickins, D.F.C., O. B. E.,** operations manager of the Royal Air Force Ferry Command at Montreal, was appointed late in January as assistant to L. B. Unwin, vice-president of finance of the Canadian Pacific Railway who has charge of the aviation activities of the C.P.R. While no definite statement was made as to Dickins' new duties, it is understood that he will be put in charge of the various airline properties which the C.P.R. bought during the past year. The C.P.R. now has control of practically every airline operating in the Dominion outside the publicly-owned trans-Canada Air Lines which supplies inter-city transportation from Halifax to Vancouver. The Canadian Pacific Air Services operate in Canada's northland, giving service to the mining camps and fur centers north of the railway as well as supplying a few inter-city services on the prairies and in the Atlantic coast provinces.

Dickins grew up in these bush lines airway operations, joining the Royal Canadian Air Force as an aerial photographer after his return from overseas in the last war where he earned the Distinguished Flying Cross and a bag of Seven German planes. He went into commercial aviation when the airplane opened up new mining areas for exploration and development in 1926 and by 1927 had mapped and flown over 4,000 miles of Canada's North West Territories never flown over before. For this feat he received the McKee Trans-Canada Trophy in 1927, Canada's highest civilian aviation award. He did much to change the fur trade by showing the value to the fur companies of aerial transport of furs during the trapping season. In 1935 he was awarded the Order of the British Empire. He has been superintendent of Canadian Airways Ltd., for a number of years, going from that post to the Canadian Pacific Railway to organize and take charge of operations of the Atlantic Ferry Command when the C.P.R. started it in 1940. Since then the R.A.F. have taken over the Ferry Command. His new work will likely be the consolidation of the various airways now controlled by the C.P.R.

*British Combine Photo*

**HARDY HURRICANES IN RUSSIA**

RAF pilots with one of their Hurricane fighters on the Soviet front during the arctic winter. Camouflage net is the only shelter. British crews turned planes and equipment over to Russian air force after familiarizing Soviet crews with their hardy fighters.

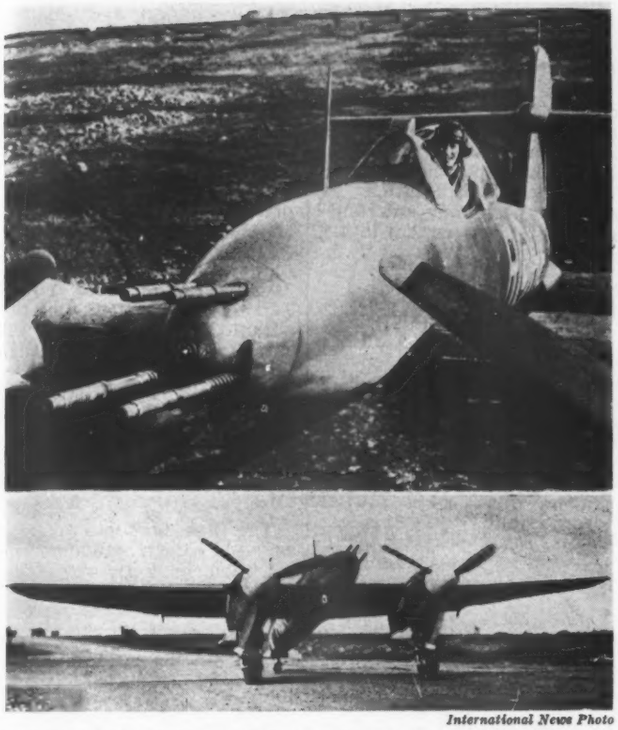


*British Combine Photo*

**AUSTRALIA BUILDS BEAUFORTS**

Australia's industries are almost completely converted to war needs. These British Beaufort torpedo bombers near completion at the end of the assembly line in an Australian aircraft plant.

**The National Research Council at Ottawa** is obtaining new facilities for its investigations of aviation problems. This



*International News Photo*

Unusual design features of Britain's new Whirlwind fighter can be seen in these views. The single-seater fighter mounts four cannon in the nose. Note air intakes in leading edge of wing and stabilizer mounted near top of the fin.

work has already paid wartime dividends and promises to be of outstanding value to commercial aviation after peace is attained. Provision is being made for experiments looking toward the elimination of the spin. Two new wind tunnels have been announced under construction, one horizontal and the other vertical.

## Atlantic Shuttle

The ferry line between America or Canada and England has been speeded up so much during the past months that an average of 15 planes crosses each day, loaded with supplies, spare parts and important passengers, and arriving at undisclosed destinations after about eight hours in the clouds.

So far, remarkably few planes have been lost, in fact, all larger equipment has a 100 percent record, and only one or two *Hudsons*, which till now have made up a great part of this traffic, have disappeared.

The whole ferry command is run like an efficient airline operation, no fancy flying or chasing after speed records is allowed, and while radio communications are forbidden, the flight plans are laid out well enough to allow a constant approximation of the flight's positions. Notwithstanding these rules, records have been broken and are still falling—the most recent one was a crossing by a B-24 in 400 minutes for the 2,200 mile distance, working out at better than 330 mph., which is good going in anyone's language.

Some of the smaller equipment which is being supplied by this country for the fighting fronts of the war, still travels across the Atlantic by boat; the tendency is toward longer ranges, though, and a few extra streamline tanks slung underneath fuselage or wings may send the larger fighters and dive bombers winging their way across too.

## Overseas Training

The Pilot Training Division of Northeast Airlines graduated its first group of civilian pilots, trained for commercial service overseas by the CAA, with a rating of Flight Officers. The first group of eight men received the advanced training in this school, the first of its kind in the country which had been set up as an experimental school at the Commonwealth Airport, Boston. They completed their final tests at Burlington, Vt., when the school moved to that point to carry on the training of 176 more trainees in cooperation with the University of Vermont in that city.

Ordinarily, the training these young men receive would fit them to fill positions as airline co-pilots.

## ON SCHEDULE . . . by "Vista"

**About a year ago** this column reported that something was afoot in Spain to reinstate cancelled Axis lines, or lines which were about to be terminated, with a "neutral commercial" Spanish airline. Since then, many things have happened; America went to war, the South American countries either expelled or seized outright German lines which were still operating down there, and Air France bid for, and lost, resumption of its lines to Brazil and Argentina. Now that the first immediate excitement about the war has died down a little, at least in the opinion of certain European interests, the efforts to reopen that vital supply and spy line over the South Atlantic are in full swing again. France is again building planes, claiming proudly that every English bombing increases the plane quota allowed by the Nazis, while testing the P-161 on the Seine. This P-161, a model of which was exhibited at the New York Fair, grosses about 43 tons, and is the largest in the world, according to Vichy, which quite forgets the Martin *Mars* or the Boeing *Clippers*, which with their new engines can also lift that much and more.

**And in South America,** unconvinced Argentina signs a "Far-reaching Pact" with Spain, which includes, besides some commercial stipulations, the enlightening provision for the establishment of a Spanish airline between Spain and Argentina. Such a line would run via Rio d'Oro on the West African coast, and probably Dakar, across the ocean via Brazil to Argentina. The last ocean jump is admittedly fairly large for any country which never built a decent long-range airplane, but there are both Italian and German seaplanes, landplanes and flying boats for which this hop is childs play.

**France has still enough gasoline** and other equipment, including spares and complete workshops, in Argentina to help such a line establish itself, and keep it running for quite some time. Spain, as a neutral, could very well run a transport full of ostentatiously Spanish made parts and supplies to Argentina, to run their "commercial" airline. While a situation, such as occurred last year, in which an American oil company kept the Axis lines going by selling them high grade gas for their operations, is not very likely to turn up again, the connection would be vital enough to the Axis partners to divert part of their fuel supply, and some of their pilots, to such a route. Especially if it appeared reasonably certain that it could be established and maintained without too much interference from the United States and its Allies.

**In the mean time,** there are quite a few modern and semi-modern airplanes of German and Italian manufacture in South America, now standing idle and gathering dust after the companies were dissolved. Reports from Washington say that purchase of this equipment is seriously considered, and before long we may see some Focke-Wulf *Condors*, Savoias, Ju-52's and other equipment in this country, where they will be doing some service for the Allies for a change. Besides their actual usefulness, they would contain valuable study material, since German construction of commercial airplanes, especially those dating from 1939, when the better material was all diverted to military equipment, was made with material not directly acceptable here. It would be especially interesting to hear whether the provisions for machine guns and bomb doors are built into these planes, just as they were built into the DLH passenger planes in plain view of the travelers.

# TRANSPORT AVIATION

## CAB Labors On Mail Rate Problem

Washington (Aviation Bureau)—Air transport's newest headache is mail rates. Traffic vice-presidents, editors, lawyers, congressmen, are swapping mad words because rates are too high and rates are too low.

This trouble boiled up because there is a heat under it, and the heat is war. The country is largely on a war basis, while the airlines, by their own wish and that of the Administration, are trying to operate on a business basis.

Under law, the Civil Aeronautics Board is charged with fixing fair and reasonable rates in accordance with the needs of the airlines. At the same time the board is required to rule for the development of air transportation, for the commerce of the country, for the service of the Post Office, and for the national defense. That is a large order. When you add the interests of investors, and consider how much profit they are entitled to, it becomes more difficult.

Now, when all those aims must be subordinated to the prosecution of the war, in which the airlines play a vital part, the problem becomes acute. It must be solved or the business basis of operating the lines will have to be suspended.

The Post Office does not like paying rates to the airlines to cover costs increased by war, for service impaired by war. The stockholders want to get paid. Airline management wants to stay solvent. Congressmen want to know why the airlines weren't given money to expand instead of having a measly 350 planes in the start of the war. The board wants to divide the cost of operation equitably among passenger, mail and express traffic. The War Department wants to make maximum strategic use of the system.

To help speed this work, the board last January adopted a new procedure. After the carrier has had an opportunity to comment on his rates, the board issues an order to him showing cause why his rates should not be such and such. If the proposed new rates are lower, of course he tries to show why they shouldn't be. If the carrier himself has filed an application for reconsideration of his rates, the board's order is the next move. The order is subject to hearing if protested. The operator can file an answer, with exhibits and statistics.

Since January, all cases have been handled under this new system, except those where hearings were completed, and those where exhibits had been filed and hearings in prospect. All hearings have been completed since then.

## Charter Trips Out

The Civil Aeronautics Board has adopted a regulation which prohibits commercial airlines from operating charter trips or special services other than regular scheduled flights. If a case of urgent necessity for special service arises, approval must be had of the military director of civil aviation. Purpose of the regulation, says CAB, is to keep unnecessary air travel in the background, clearing the way for transportation of military personnel and supplies and other services to aid the war effort.

## PCA to Washington

Penn-Central, on April 21, completed moving its operation, traffic, executive, maintenance, and all department headquarters to National Airport at Washington, D. C. Company's new quarters occupy two of the large new hangars, with offices in the upper level. PCA's institutional design program, with its standard rust, green and gray colors, is carried throughout airplanes, offices, equipment, and even stationery. Many new maintenance features have been developed.

## TWA Releases Boeings

TWA has turned over to the Army its fleet of five Boeing four-engined stratoliners, which have a long operating range and are much needed for war operations. Fittings are being stripped from the ships to increase this range.

In exchange, TWA will get equivalent passenger capacity in other types, out of the allocation of planes to the airlines. The Boeings carry 33 passengers, or a total of 165. It would take seven DC-3s to replace them.

P. E. Richter, TWA vice president, said his line's schedules would not be interrupted.

## TCA Plans Extensions

Trans-Canada Air Lines expects to inaugurate a regular daily passenger, mail and express service to Newfoundland on May 1. Upon completion of the Canadian Government Airway between Edmonton, Alta., and Whitehorse, Yukon Territory, expected in the autumn, Trans-Canada will extend its services to that territory. It will provide a direct main line service from the United States and Canada to Alaska.

## Alaska Air-High-Way

The first combination highway and airway is under construction, by the Army Engineers, between the United States and Alaska via Canada. The 1500-mi. road, being rushed to a usable condition by winter, follows a line of important Canadian airfields, through Fort St. John, Fort Nelson, Watson Lake, Whitehorse, Boundary, with connections to Fairbanks and other points in the North. Paved roads connect Fort St. John with Great Falls, Mont. and other U. S. cities. Congress will authorize about $20,000,000 for the job.

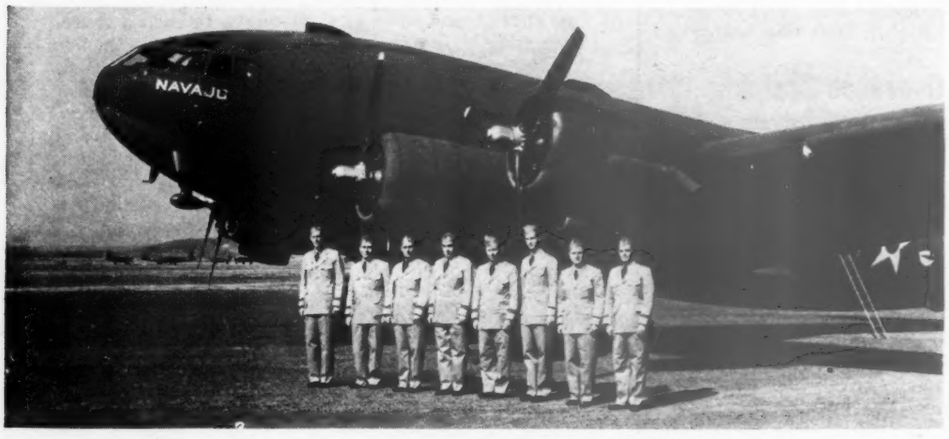
This route was selected because it is far inland, in better weather and out of reach of air attack. The air-motor trail will carry vast quantities of supplies to Alaska, relieving coastwise shipping. The Public Roads Commission will develop a paved highway, after the Engineers get traffic moving on the "pioneer" grade.

The United States Army proposes to make a contract with Northwest Airlines for operations between the U. S. and Alaska. On what route is not stated. Presumably the Army will carry on transport operations also. Two air connections with Alaska are already operating: Pan American from Seattle and a series of connections from Lethbridge.

## Pilots Fly 100 Hr. Lines Lose 175 Men

Transport pilots will fly 100 hours a month instead of 85, as they have for several years, under the civil air law. Congress has amended the law, under pressure from the Army and Navy. During recent weeks, the services have taken between 150 and 200 reserve pilots from the airlines, for active duty.

Airline experience is badly needed, now that air war no




OFF TO THE WARS

Former luxury airliner takes on a coat of war paint and the insignia of Air Corps Ferrying Command as it gets ready to take off for the foreign front. This ship—with crew—is one of the five Stratoliners turned over to the Army by Transcontinental & Western Air, Inc., to serve in a foreign courier service. Pictured above are crew, left to right:—Peter H. Redpath, navigator; W. L. Noftsinger, second officer; Donald Terry, first officer; Otis F. Bryan, captain; Milo Campbell, first officer; W. R. Shook, radio operator; Robert L. Proctor, flight engineer; Guy Arnold, navigator.

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*(At Left) Dowty Levered Suspension Main Landing Gear.*

*Dowty Nose-wheel Landing Gear Assembly.*

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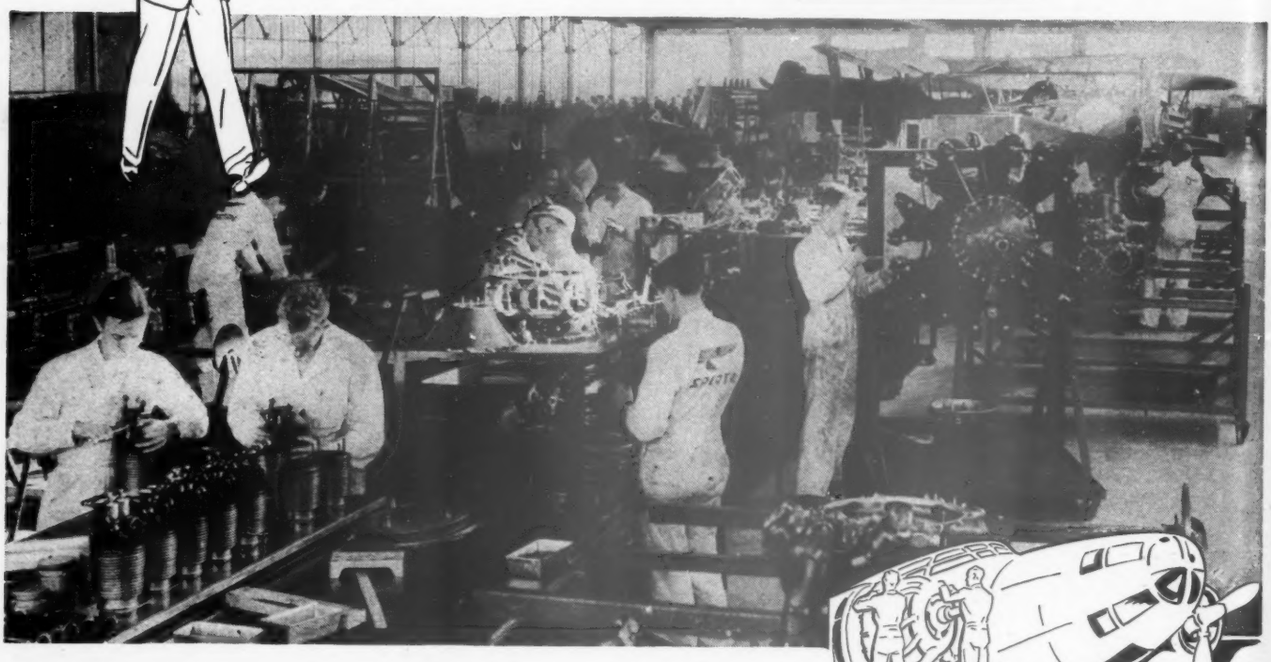

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longer waits for clear weather, and military transport itself is highly strategic. All air agencies of the government, the Air Transport Association, and the pilots themselves, approved of the measure.

Original purpose of the hours limitation was prevention of fatigue, for safety. The only answer now is for pilots to take more time for rest, less for fun. Penn-Central alone lost 13 pilots. Co-pilots are moving over to the lefthand seat. Trainees are being pushed into co-pilot jobs. Older pilots, long since retired to ground jobs, are going aloft.

## Radio Test Devices

Two new devices for testing aircraft radio equipment have been designed and produced by United Air Lines for use in service shops along its routes. One device, is a vibration generator for testing radio equipment under conditions in excess of those encountered in flight. An air-operated generating unit with an electrical frequency control is connected with a test table which can be rotated through 360 deg. for inspection of equipment during test. A means is provided for increasing or deceasing the amplitude of vibration, with a maximum intensity of 3 "g's" for a 100-lb. load.

The other device is a signal generator for aligning and measuring the frequencies of all radio receivers carried aboard United's *Mainliners*. It is made for the operation of 24 crystal-controlled frequencies but can be adapted to as many as 40.

## Patterson Looks Ahead

Extensive post-war growth of aviation was forecast by W. A. Patterson, president of United Air Lines in a statement before the Investment Bankers Association at Chicago.

Patterson foresees airlines in a strong financial position following the war, despite expected advances in cost of operation. Airplanes, he said will increase in cost; he cited the jump of $30,000 in the price of the Douglas transport in one year. Taxes will climb he said, as will training of personnel.

High cost of rapid expansion will cut down the number of domestic lines, he thinks, but he said six to nine lines will fly the Atlantic; two or three will be American owned and operated.

Patterson said the potential economy of air transport is manifest. Cost of the *Queen Elizabeth* would build enough airlines to fly the Atlantic operating every hour on the hour from 9 a.m. to 10 p.m. each way.

Following the 10 percent rail rate increase, Harold Crary, traffic vice-president of UAL, quotes New York-Chicago air passenger rate of $38.20 as compared with first class rail fare of $36.30, with meals and tips en route more than offsetting the difference. Rail time is 17 hr. as compared with 5 hr. by air. These relative costs are bound to pull a huge volume of business.

Instrument landing, promised after the war, eventually will enable the airlines to approach surface schedule performance.

*United Air Lines photo*

**SAFETY TIP WINS CHECK**

A check for $130 from United Air Lines caught up with Lieut. Jack Larsen for the best safety suggestion turned in by United employees in 1941. Larsen, left, is shown receiving check from Capt. Olin L. Day, commanding officer, 10th Materiel Squadron, Scott Field, Ill. Lieut. Larsen's suggestion, made before he went into the Army, outlined a system for the safe operation of motorized vehicles in the proximity of flying equipment.

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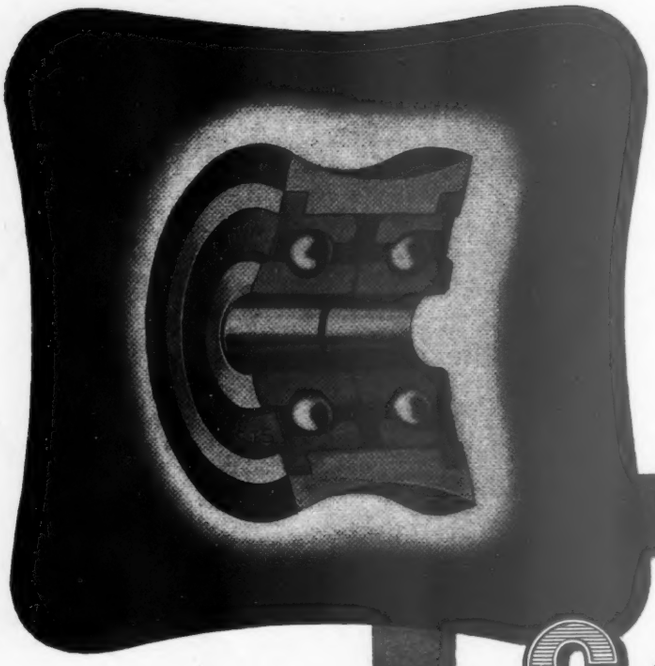

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**Uncle Sam continued to benefit from the operating economies affected by the aircraft industry.** Last month this department pointed out a number of companies which were voluntarily returning funds to the government. Since then **J. H. Kindelberger,** president of **North American Aviation** reveals that increased efficiency had reduced the cost of warplanes to the extent that his company had returned $14,000,000 to the government rather than accept it as profit. North American, it seems, has reduced the cost of a plane 33 1/3 percent over the cost of the same plane in the summer of 1940, when the cost of both men and materials were lower.

At the same time, **P. G. Johnson, president of Boeing,** reports that quantity production with modern facilities designed for that purpose have brought a substantial reduction in the cost of building the famous *Flying Fortress* and that Boeing is preparing to make a material cut in the price of this plane to the government.

**Continental Motors** has made a $40,000,000 reduction in the price of its aircraft and ordnance contracts. Company officials say the reduction was made possible by increased efficiency, plant economies, improvements in methods and "the wholehearted cooperation of its employees."

**Thompson Products, Inc. is maturing plans to sell new common stock** in order to increase working capital, according to Cleveland reports. Present shareholders may be offered rights to purchase additional stock. Sales of aircraft products last year jumped to $17,951,000, as against $8,504,000 in 1940. To keep pace with the increasing requirements for its products larger inventories must be carried and a record sales volume must be financed from working capital. The original peak output of the aircraft division was placed at $1,800,000 a month, according to F. C. Crawford, president, but now it is expected to reach $2,500,000 within this year.

**A round-up of the government contract procedure** of a number of the larger companies would indicate that the majority are operating on a fixed-price contract basis with respect to government orders. Boeing received a fixed fee contract from the government in 1940 with the provision that after a certain number of bombers were delivered the costs of performing the contract would be reviewed. Vultee contracts are on a fixed-price basis. At the end of last year over 50 percent of the war orders of the Glenn L. Martin Co. were fixed price contracts with deliveries under these contracts continuing through 1942 and 1943. With few exceptions, contracts of United Aircraft Corp. also are of the fixed-price type. On the other hand over one-half of all of Consolidated's orders were stated recently to be cost-plus-fixed-fee. Lockheed is switching over to the latter method from the fixed-price contract formerly used exclusively.

★ ★ ★ By RAYMOND HOADLEY ★ ★ ★

A NEW APPROACH to the problem of securing working capital to finance the ever increasing production of warplanes has been adopted by Lockheed Aircraft Corp. The financial burden of expanding inventories and work-in-progress usually has been met in the past by bank loans or public stock financing. But with working capital requirements increasing so rapidly, Lockheed no longer considers the customary financing methods of the industry to be feasible and has decided to adopt the cost-plus-fixed-fee type of contract as opposed to the fixed-price contract under which Lockheed and the majority of other aircraft manufacturers have operated in the past. Under the cost-plus contract the producing company is virtually relieved of any necessity for working capital insofar as production itself is concerned. The government buys the materials and pays the labor. The company is relieved of the need of securing large amounts of extra capital and can forget about bank credits and stock financing. It might obviate the present day need of plowing nearly all the earnings of aircraft companies back into working capital and thus give the stockholder a better break with respect to dividends. But, more important still from the long-term viewpoint, it may enable aircraft companies to enter the post-war era without the back-breaking burden of an inflated capital structure at a time when a 20 or 30 billion dollar war business has suddenly stopped. The aircraft companies have seen what havoc a crushing debt burden has played with the railroad industry and should continue their present comparatively light capital structures at all costs.

Meanwhile it will be another two or three months before the new tax bill is acted upon by Congress. And until the extent of the new tax levies are known it is idle to speculate on what the probable earnings of the aircraft or any other American industry will be in 1942. With the tax bill in mind most aviation companies are setting up huge tax reserves in the first and second quarters of the year, hoping against hope that they will be more than ample to foot the bill.

The domestic airlines have been setting new passenger traffic records for so many years now that it is news only when they fail to do so. This may be the year when "the man bites the dog" for there are war developments shaping up that can easily have a rather serious effect on airline traffic. It is by no means sure that the transport companies will get all the new planes they were promised earlier in the year and the transport of war goods may make far more serious inroads on available passenger space than they have to date. The airlines right now are doing more war work than the average person knows about and much of it is the sort of thing that can't be publicized.

★ ★ ★ ★ ★ ★

**Post-War Planning.** Robert E. Gross, president of Lockheed, reports to stockholders that the first duty of the aircraft industry is to produce tools to win the war and that its second duty is to set up sufficient reserves out of profits to protect the system of free enterprise in the post-war period. Consolidated Aircraft's annual report points out that its newest products may be readily adapted to future commercial use and that the company remains in a favorable position to take advantage of the "opportunities which will present themselves when once again our aircraft with improved speed, comfort and utility fly the commercial airlanes of a peaceful world." The Glenn L. Martin annual report tells of new and experimental aircraft and accessory developments that are being brought to productive realization with all possible speed. Many of these projects will be applicable to commercial aircraft operations in the post-war period.

**Vultee** annual report points out that work done in 1941 on products to be delivered in 1942 constituted 62 percent of its year-end inventory. The company did not have any cost-plus a fixed-fee contracts at the time the report was issued.

**Thomas Fortune Ryan, III,** who owns a controlling interest in Mid-Continent Airlines, has resigned as president to enter service and has been succeeded by J. W. Miller. Mrs. Ryan, J. A. Zock and Theodore S. Ryan have been elected members of the board of directors.

**Fleetwings** has been able to reduce man hours worked on liaison airplane control surfaces by 7 percent and 14 per cent on bomber tail assemblies, according to Frank de Ganahl, president. Delivery schedule requirements, he said, have been bettered by wide margins on every contract.

**Packard Motor Car** has received a very large additional order for Rolls Royce aircraft engines. This new order supplements others received some time ago from both the American and British governments.

**An indication** of the extent to which air express is being used in the war effort can be read in the 135 percent gain in air express poundage flown by United Air Lines in the first two months of 1942 over the similar 1941 period. The 1942 increase is ascribed by company officials chiefly to large cargo movements between industrial areas.

**Grumman Aircraft** delivered more airplanes in 1941 than in the four preceding years and will deliver four times as many in 1942 as it did last year, L. R. Grumman, presi-

dent, told stockholders in his annual report. He also disclosed that General Motors Corp. will manufacture certain Grumman models for the Navy.

**Kellett Autogiro Corp.** repaid late last year the $175,000 loan which was negotiated with the RFC in 1940. The company has been financing its big business volume by bank loans which have been made available as required.

**Control of Sperry Corp. now rests with the stockholders for the first time.** For the past nine years control of the concern has been vested with five trustees. Termination of the voting trust agreement by these voting trust trustees permitted stockholders to exercise their director-election and other voting perogatives at the April annual meeting for the first time. Voting trust certificate holders now will receive common stock in exchange and the new common will be listed on the New York Stock Exchange in place of the old certificates.

**The aircraft industry** has been asked to contribute $500,000 to the Navy Relief Fund. Guy W. Vaughan, president of Curtiss-Wright Corp., is chairman of the aviation committee for the drive and Curtiss-Wright started the ball rolling with a $50,000 donation.

**Republic Aircraft** set new production records in February, according to the annual report of W. Wallace Kellett, president. Substantial additional orders have been received for the P-47 and the design of this warplane has been made available to other manufacturers at the request of the government. Meanwhile company engineers are developing new models of military aircraft.

**Current Earnings Reports**

| Company | Period | Net Profits 1941 | Net Profits 1940 | Profits per Share 1941 | Profits per Share 1940 | Sale 1941 | Sale 1940 |
|---|---|---|---|---|---|---|---|
| Boeing Aircraft | 12 mos. Dec. 31 | $6,113,144 | $374,655 | $5.65 | $0.34 | $93,893,090 | $19,390,718 |
| Consolidated | 11 " Nov. 30 | 8,024,882 | 1,400,645 | 6.22 | 1.03 | 95,529,050 | 9,349,550 |
| Eastern Air Lines | 12 " Dec. 31 | 1,609,706 | 1,575,456 | 2.81 | 2.75 | 13,977,434 | 11,009,713 |
| Fairchild Eng. & Air | 12 " " " | 541,079 | L 60,771 | ..... | ..... | 13,802,436 | ..... |
| Grumman Aircraft | " " " " | 1,066,683 | 1,415,964 | 2.10 | 2.79 | 21,858,680 | 8,811,294 |
| Kellett Autogiro | " " " " | 117,373 | ..... | ..... | ..... | 1,791,217 | 738,478 |
| Lockheed | " " " " | 6,608,621 | 3,165,675 | 6.14 | 3.17 | 144,728,153 | 44,936,595 |
| Glenn L. Martin | " " " " | 5,773,148 | 5,424,489 | 5.24 | 4.94 | 67,237,688 | 30,663,337 |
| Packard Motors | " " " " | 2,061,323 | 774,147 | 0.14 | 0.05 | 100,817,403 | 69,235,169 |
| Republic Aircraft | " " " " | 781,119 | 923,332 | 0.69 | 0.83 | 10,793,021 | 10,313,740 |
| Sperry Corp | " " " " | 8,281,511 | 7,854,176 | 4.11 | 3.90 | 38,315,060 | 20,126,641 |
| Stewart-Warner | " " " " | 1,656,689 | ..... | 1.30 | ..... | 53,933,908 | ..... |
| Thompson Products | " " " " | 1,722,689 | 1,670,844 | 5.36 | 5.17 | 42,459,891 | 25,225,963 |
| Trans-Canada Lines | " " " " | 302,436 | 539,263 | ..... | ..... | 5,807,794 | 4,592,383 |
| United Air Lines | " " " " | 598,050 | 775,462 | 0.40 | 0.52 | 19,362,119 | 16,179,996 |
| Warner Aircraft | " " " " | 280,824 | 95,124 | 0.56 | 0.19 | ..... | ..... |
| Western Air Express | " " " " | 5,980 | 139,585 | ..... | ..... | 2,019,345 | ..... |

L — Loss.

**Here and There . . . American Central Mfg. Corp.** is the new name of Auburn Central Mfg. Corp., 50 percent of whose stock is owned by Aviation Corp. . . . **Earl D. Osborne,** president of **Edo Aircraft Corp.,** and **John Bromley** have been elected directors of **Kellett Autogiro Corp.** . . . The number of passengers carried by **Trans-Canada Air Lines** in 1941 increased 60 percent, air mail gained 50 percent and air express was up 64 percent over 1940. . . . **Douglas Aircraft** employees contributed more than $67,000 to the Red Cross in the recent drive. . . . **Borg-Warner** devoted 11 percent of total operations in 1941 to aircraft production. . . . **Glenn L. Martin Co.** constructed 610 housing units near its Maryland plants. . . . **Cessna** directors will consider authorizing a dividend shortly after the interim financial report is issued, according to Wall Street financial circles. . . . Sales of **Thompson Products** this year are expected to be nearly double those of 1941. . . . **Curtiss-Wright** is building its fifth airplane factory, where plywood transports will be made.

## On the Raw Materials Front

**THE LIMITING FACTOR** on aircraft assembly line production these days is the sometimes erratic flow of gadgets, accessories and parts vitally essential to plane manufacture and, of course, the threat of shortages in raw materials. Right now the raw material problem appears the less disturbing. The huge aluminum and magnesium expansion programs that have been described from-time-to-time in this column are moving forward according to schedule. Increases in the supply of nickel are also on the way although for some unknown reason less is known about the nickel supply situation than any of the other critical materials used in the war production program.

Those who follow carefully the recent developments in rubber believe that plane manufacturers as well as other war industries have real reason to be concerned over the future supply status of this necessary material. The government's stockpile of nearly 700,000 tons of crude rubber may seem fairly large right now but it is a moot question whether the supply will hold out until the projected synthetic rubber program is ready to take over. The machines of war that America is forging at an ever accelerating pace have a ferocious appetite for rubber.

Furthermore, the supplies of crude rubber in both Great Britain and Canada are disappointingly low considering the fact that the British Empire formerly held control over most of the world's rubber supply and were presumed to have laid in a substantial supply. Now Britain, Canada and other United Nations as well are becoming dependent on the United States for their rubber supply.

It probably will be late in 1943 or 1944 perhaps before synthetic rubber production reaches truly impressive proportions. The bottleneck there is likely to be the raw materials—butadiene and styrene—that will be provided by the petroleum and chemical companies rather than the manufacturing process which will be handled by the rubber companies.

There is another point of concern in the synthetic picture. While it has been pretty well demonstrated that synthetic rubber is practically as good as natural rubber for passenger tires, man-made buna rubber has not proven to be a ready substitute for crude rubber in the case of heavy military truck or armored cars. In fact, experiments show that buna tires give only about one-third as much service as natural rubber for this type vehicle. Synthetic rubber is only in its early development stages in this country. Not more than 12,000 tons were produced all told in 1941. As the rubber, chemical and petroleum industries give their all-out attention to this necessary material it is hoped that improvements may be made that will increase the heavy vehicle tire life of this material. Unless that can be done the present 700,000 tons synthetic rubber program is inadequate for the future military needs of a long war.

The scrap rubber situation is also acute. Scrap is now our first line of rubber defense since crude supplies have been shut off from the Far East. Since Pearl Harbor collections of scrap rubber are only 50 percent of the former intake. Approximately 100,000,000 old tires are needed for scrap purposes in the next two years. If they are not forthcoming voluntarily, drastic measures such as the requisitioning of passenger tires may be necessary eventually.

It is not generally realized how essential rubber is to plane production. More than 50 different articles made from crude rubber or rubber synthetics are used in the production of aircraft, according to the Aviation News Committee. Most important are tires and tubes, which range from 5-in. tail wheel tires to huge casings weighing several hundred pounds for multi - engine bombers. Although airplane tires travel relative short distances, they bear tremendous weights and are subject to great stress due to high speeds during take-offs and landings.

As more and more aircraft are being equipped with superchargers for substratosphere flying, the need for rubber deicing equipment is steadily increasing. Other rubber accessories essential to plane construction include bullet-proof tanks, hydraulic hose for brakes, flotation bags and various tubings. Actually rubber has become as strategic a necessity as aluminum for aircraft production and the supply outlook is much more cloudy than it is for the white metal.

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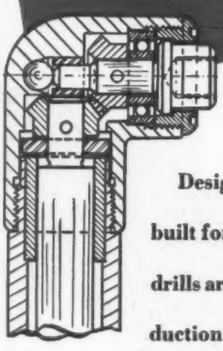
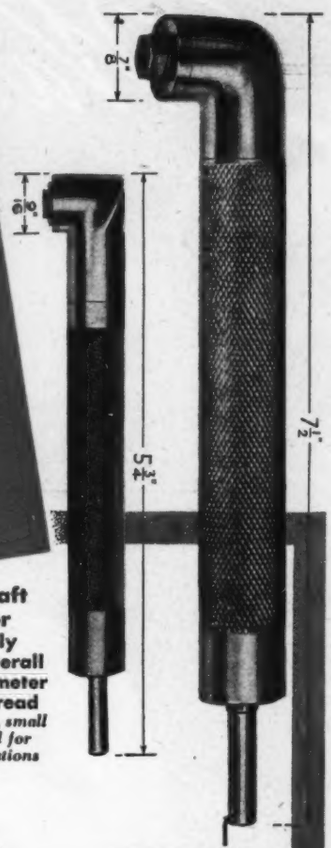
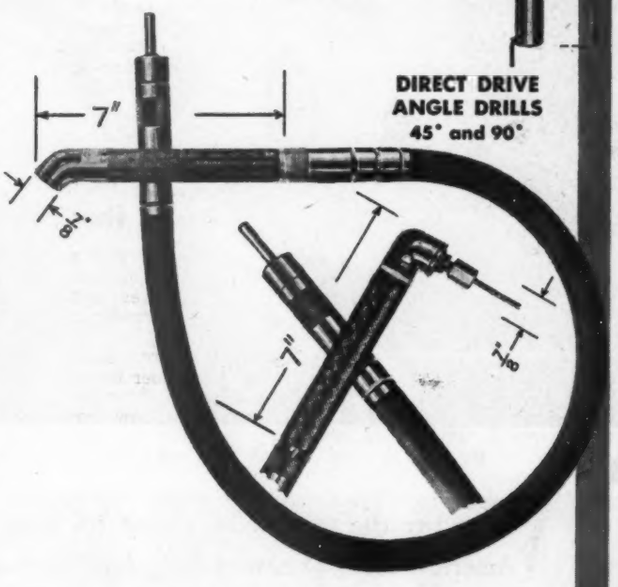
## ANGLE DRILLS





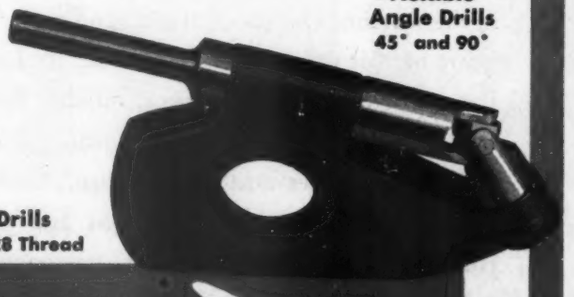

**Aerocraft Junior**
**90° only**
**9/16" Overall Head Diameter**
**10-32 Thread**
*New, husky, small angle drill for close operations*

Designed for high speed operation and built for long life, Aerocraft heavy-duty angle drills are sturdy and dependable under all production conditions. Ball bearings insure quiet, cool operation. The flexible shaft is 30" of high grade steel core with rubber-covered casing. Drill heads have ¼-28 threaded spindle. When used with Aerocraft drill adapters for holding small drills, these angle drills serve a wide range of functions in manufacturing plants and maintenance shops.




**DIRECT DRIVE ANGLE DRILLS**
**45° and 90°**

**SEND FOR THE NEW CATALOG—**
on your business letterhead, please. It shows the complete line of Aerocraft stop countersinks, back countersinks and spotfacers, rivet sets, rivet squeezers, angle drills and attachments, plastic hammers, hole saws, sheet holders, bucking bars.



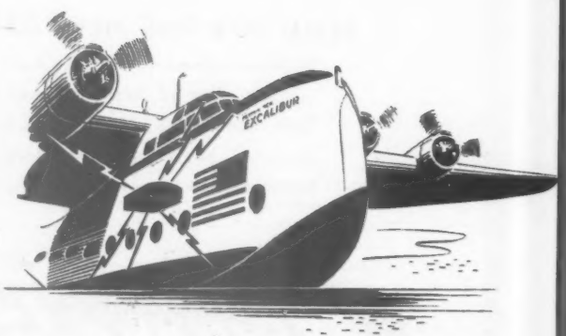
**Flexible Angle Drills**
**45° and 90°**

**Porkchop Angle Drills**
**45° ¼" Shank ¼-28 Thread**

Aircraft TOOLS, INC.
750 EAST GAGE AVENUE . . . LOS ANGELES, CALIFORNIA

# Warrior without Arms

NAMED for the legendary sword of King Arthur, American Export's newest flying boat, the huge Flying Ace "Excalibur" will soon be meeting exacting schedules in the wartime transport of men and materiel. The stout heart of this great modern airliner, its Lawrance Auxiliary Power Plant, supplies a reliable flow of current for engine starting, light and heat, galley hot plate, communications and ventilation. Contributing to increased efficiency of operations and the utmost in comfort and convenience for passengers, this new source of power for a giant of the skies marks a long step forward in the progress of air transportation.




Lawrance

ENGINEERING AND RESEARCH CORP.

LINDEN, NEW JERSEY

**EMIL K. HARVEY,** formerly director of the Airport Division of Haller Engineering Associates, Inc. has been named chief of design section for the projected Idlewild Airport construction to be undertaken by the municipality of New York in Queens.

**J. L. HARKNESS** has been appointed chief engineer of the Nashville Division of Vultee Aircraft, Inc. He had formerly served fourteen years with Vought-Sikorsky Aircraft Division of United Aircraft Corporation in various production departments.

**HARRY T. ROWLAND,** veteran in the field of aeronautics and former sales manager for the Glenn L. Martin Company, has been elected a vice-president of that company. He will serve as assistant to the executive vice-president, Joseph T. Hartson.

**STANLEY R. SHATTO** has been elected vice-president in charge of engineering and maintenance for Continental Air Lines, Inc. He was formerly supt. of maintenance for the line and supervised installation of the new overhaul base at Denver.

The Boeing Aircraft Company has accepted the offer of **WILLIAM E. BOEING,** pioneer aircraft builder and founder of the Boeing Company to serve the company in a consulting and advisory capacity for the duration of the war.

**EDWARD S. RIDLEY,** former assistant director of the Economics Compliance Division of the Civil Aeronautics Board has been elected vice-president and director of Canadian Colonial Airways according to a statement made by president Sigmund Janas.

**MARION P. CREWS,** former CAA official was made Dayton representative for Boeing. He will act as liaison man for all branches of the Boeing companies with the Materiel Division of the Air Forces, handling both business and engineering relationships.

**JOHN OLMSTED, JR.** has joined the Buffalo flight test section of Curtiss-Wright. He was formerly chief pilot in charge of cross-country flying at Benson Niagara from the Air, Inc. He received multi-engine flight training at the Boeing School.

**FRANK E. CALDWELL,** former chief of the investigation division of the Civil Aeronautics Board, and a pioneer in aviation, has recently been appointed assistant to George Gardner, vice-president in charge of operations of Northwest Airlines, Inc.

**ROBERT L. DAVIDSON** has been newly appointed sales manager for the Aeronca Aircraft Corporation. He will be in charge of all civilian pilot training program and civil air patrol sales and in addition will handle certain army coordinations.

**G. J. BRANDEWIEDE,** Curtiss-Wright executive, has been named general manager of the new Curtiss-Wright plant to build military transport planes almost entirely of wood and non-strategic materials. The new plant is to be erected soon.

**G. W. VAUGHAN,** president of Curtiss-Wright Corporation has accepted the invitation to serve as chairman of the National Committee of the Aviation Industry to assist in raising the industry's portion of five million dollars for the Navy Relief Society.

**GORDON C. SLEEPER,** World War flier and prominent business figure, formerly with the New York brokerage firm of Reynolds and Company is a member of the executive staff of Republic Aviation Corporation as assistant to President Ralph S. Damon.

**S. JACK INGRAM** has assumed title to the newly created position of assistant to the president at Braniff Airways, Inc. In his new position, Ingram will work on organizational and personnel matters with all departments of the airline organization.

**GEORGE W. MASON,** pres. of Nash-Kelvinator Corporation was elected a director of the Square D Company, a large producer of precision aircraft instruments. Mr. Mason is a prominent figure in the automotive and electric refrigeration industries.

# Recent Books

**AIRWAYS — THE HISTORY OF COMMERCIAL AVIATION IN THE UNITED STATES, *by Henry Ladd Smith. Published by Alfred A. Knopf, New York. 404 pages, including indices, illustrated, $3.50***

This book is much more than just the winner of the first Knopf Fellowship in history, it is the first comprehensive and objective account of the growth of the greatest air transportation system in the world.

Background beginning with the Wrights' first Kitty Hawk flights is carried through the early struggles to keep planes in the air and in one piece, through events of World War 1—presenting many interesting parallels with some of today's talk—on through the famous barnstorming days.

Details of the financial battles, equipment developments, politics, personalities —all the factors making up one of the most fascinating stories in American industrial history—are carried forward in a running story as good as a novel.

Even those who consider themselves old timers in the aviation industry will learn parts of the story behind the story they never knew; anyone just getting into the business will find it invaluable as a source of information as to just why many events happened when they did.

Airways couldn't have been written much earlier in the game, but it is fortunate that its writing and publication came when they did. The book is very well written and exceptionally well documented; a "must" for any aviation library, a worthy addition to any other.

**HOW TO CREATE JOB ENTHUSIASM, *by Carl Heyeh. Published by McGraw-Hill Book Company, New York. 248 pages, $2.***

An important and timely discussion of the techniques and philosophy useful in creating favorable personnel relationships is presented in this book by Carl Heyel of the management staff of the Union Bag and Paper Company. The concise and helpful text is illustrated with hundreds of examples of the successful handling of employee relationships in many types of companies.

By analyzing the new "progressive philosophy" that the author believes management must entertain today, a practical formula is developed for getting people who work for you to carry out—satisfactorily and willingly—what you want them to do.

This book should prove widely useful to the management of aircraft plants whose problems of expansion and added production require a maximum of cooperation on the part of management and labor.

**THE HANDBOOK OF AERONAUTICS AND GROUND INSTRUCTOR'S AID, *by Ed Ellsworth Bartholomew. Published by Question-Air System, Kilgore, Texas. 128 pages, paper bound, $2.75.***

Written for both flying and ground license applicants, this quiz-text is designed to serve, first, as a system of study, and second, as a means of familiarizing the student with the multiple-choice type of question employed in examinations for certificates.

It includes five subjects—Civil Air Regulations, both old and new; meteorology; airplanes and aerodynamics; and aircraft engines—with text and simulated questions intended to cover each field for the various types of licenses.

Each section has 200 questions and the book contains detachable examination sheets on which the reader can test himself, grading according to a question key found at the end of each chapter.

A well arranged guide for those heading toward license exams.

**33 LESSONS IN FLYING, *Jay D. Blaufox. Published by Coward-McCann, New York, 319 pages, illustrated, indexed, $2.50.***

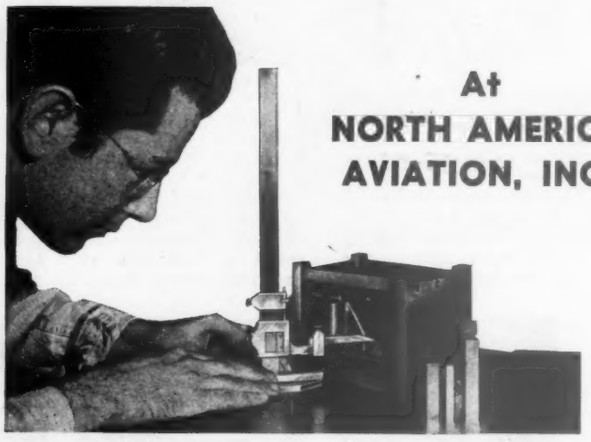
Mr. Blaufox's book on flying takes the student through the primary stages of flight training and his first solo flight, but the stress is on advanced flying and acrobatics. It is a series of lessons giving much friendly advice to pilots, telling of "short cuts" and aids to assist the student in expert and safe handling of the plane. It has tips on war or combat flying.

The author says that he has attempted to answer questions not met by ordinary texts on flying, such as overcoming obstacles, storms, clouds, fogs, higher altitudes. He points out the differences in handling various kinds of planes and discusses their maintenance.

**AIRCRAFT TEMPLATE DEVELOPMENT, *compiled and edited by Aero Publishers, Inc., Glendale, Calif. 310 pages, including appendices. Illustrated, $4.00.***

A sound, simply written text for the mechanic or apprentice who wants to become a template maker—one of the classifications listed in the Occupational Questionnaire going out from the government to the latest draft registrants.


STARRETT



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NORTH AMERICA
AVIATION, INC.

North American bombers and fighters are doing their bit in every theatre of combat. In North American plants, Starrett Tools are contributing sure accuracy and dependability. This craftsman is checking a drilling jig in a North American toolroom. Write for Starrett Catalog No. 26 V.

THE L. S. STARRETT CO.
*World's Greatest Toolmakers*

*Precision Tools . . . Dial Indicators . . . Ground Flat Stock*
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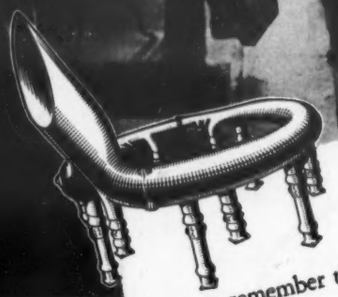
STARRETT TOOLS

# Manifold Deliveries ON TIME



In considering your exhaust manifold requirements remember that Ryan offers: (1) Research background and engineering talent to grasp your particular problems immediately. (2) Resources, tested facilities and extensive experience for volume production. (3) The habit of delivering on time, according to schedule. Engineering consultation is invited.

**RYAN AERONAUTICAL CO.**

*Lindbergh Field, San Diego, Calif.*

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Famous Ryan S-T Trainers

# *For a bomber's arteries— cushions of* HYCAR

THE arteries of a bomber are the hundreds of small tubes that carry fuel and oil throughout its complex interior. Reaching into every part of the plane they must pass through a great many structural members — ribs, partitions, and other parts.

To cushion and insulate these vital arteries, aircraft builders are using grommets and line supports made with Hycar synthetic rubber—millions upon millions of them.

Why Hycar? For its superb resistance to oil and aromatic gasolines. For its light weight (specific gravity: 1.00). For its excellent heat resistance, its age resistance, its resistance to abrasion, cold-flow and permanent set.

The qualities that made Hycar ideal for the tubing—the arteries themselves—are the same qualities that dictate its use for grommets in our modern war planes. These are the qualities that make Hycar one of the most valuable developments of our time.

**HYCAR** *Chemical Company*
AKRON, OHIO

Practically all of the nation's leading aircraft producers have contributed to the text designed to teach "the art and science of making aircraft templates the way the manufacturer wants and must have them."

Topics covered include general aircraft nomenclature, mathematics for the template maker, principles of mathematical development, essential tools and equipment and photographic reproduction of templates, the latter covering much the same ground as the article in AVIATION for February, 1942. There is also a series of 46 problems on typical aircraft parts, utilizing blueprints made available by Lockheed Aircraft Corp.

**THE BLUE BOOK OF AMERICAN AVIATION, *Second Edition; by J. Alfred Miller and George J. Searle. Published by the Aviation Statistics Institute of America, Asheville, N. C. 242 pages.***

Lists personalities of the industries; national organizations; aviation periodicals; state aviation officials and personnel; aviation schools and colleges; airlines; airports served by scheduled lines; and aircraft, parts and supply manufacturers. Also devotes a section to "official Washington" and contains a classified buyers guide.

**AIRCRAFT TORCH WELDING, *by C. Von Bochers and A. Ciffrin. Published by Pitman Publishing Corp., New York. 149 pages, including appendices. Illustrated, $1.50.***

A compact, basic text for beginners to be used in connection with practical instruction for both construction and repair and maintenance. It gives considerable attention to government specifications and the tests which must be passed by work being done to meet such requirements.

Safety precautions—particularly valuable in these hurry-up days—are stressed throughout the book.

Self-testing questions follow each chapter, and an answer key is provided.

**WHAT'S THAT PLANE? *Published jointly by Penguin Books, Inc., New York, and The Infantry Journal, Washington, D. C. 188 pages, paper bound, 25 cents.***

This is a pocket-size guide to aircraft recognition, using both silhouettes and photographs, many of which have appeared in AVIATION. It concentrates on military craft of the United States, all the currently-flying Japanese planes of which silhouettes are available, and long-range German sea planes "which, operating from mother ships in the Atlantic, might attack the eastern portions of the United States and Canada."

For Horizontal Drilling
MODEL 30-435 S

Clark DRILLS fit the JOB AND THE MAN

THE DESIGN SAVES HOURS OF MAN POWER

For Vertical Drilling
MODEL 30-435 SC

To meet the ever increasing demand for more planes, tanks, guns, and other armaments, Clark's newly designed line of Portable Electric Drills cut fatigue to the minimum.

Note in the photographs how the wrist is always in natural position—whether drilling in a horizontal or vertical position. Model 30-435S is ideal for horizontal work and Model 30-435SC is just right for vertical drilling.

This energy saving design, along with Clark's controlled Construction Method, make Clark drills the "answer" in stepping up production in the greatest airplane, tank, and other armament manufacturing plants throughout the country.

Since 1892, when James Clark, Jr., designed and built the first portable electric drill, Clark's drills have always been first in design and quality. Let the name Clark be your guide to complete satisfaction for electric drills, grinders, and sanders.

"first in the field" CLARK Electric Tools

JAS. CLARK, JR. ELECTRIC CO.
606 BERGMAN ST., LOUISVILLE, KY.

AEROBATICS . . . cross-country . . . formation flying . . . they're all in the day's work for the new Fleetwings basic trainer which is being built for training our Army's flying cadets.

Sturdy, maneuverable, *air-worthy*, the BT-12 handles like a thoroughbred. Powered by a 450 H.P. radial engine . . . the world's first military airplane built principally of stainless steel.

Fleetwings engineers . . . who designed and are constructing the BT-12 in quantity . . . have a long record of successful pioneering. They have developed new spot welding methods, a new straight-line-flow system for mass production, new designs, aircraft surfaces and hydraulic equipment.

Today, Fleetwings helps *get* 'em flying by pushing production to record levels, both in quantity and quality. At the same time, Fleetwings points toward bigger, tougher, fleeter warplanes tomorrow . . . shaping wings for the day of Victory!

★

FLEETWINGS

*Incorporated*

BRISTOL • PENNSYLVANIA

## Production Report

(*Continued from page 73*)

home army". How well we are succeeding is best and most safely revealed by the production increase since Pearl Harbor that I have mentioned, and by telling you that our aircraft plants are ahead of the schedules set for them by the government. In this latter connection remember, President Roosevelt called for 60,000 planes this year.

There is still another means of letting you know how well plane production is getting on. Recent weeks have seen many plane companies returning to the government large portions of their profits. This has been made possible by the unceasing effort of our people to find new production devices and techniques to increase production. In this battle of brains, our people have been so successful that man-hours of work on aircraft have been spectacularly reduced, sometimes cut in half. These production victories have cut the cost of warplanes to the taxpayers by cutting the time it takes to build them, and obviously, has made possible the construction of thousands of additional planes in the time saved. Every one of these additional planes has been built, without delay, to the extent that the material supply has allowed.

There is one very real enemy standing squarely in the path of American victory in this, and this enemy is endangering aircraft production along with other production. This enemy is the "oral saboteur", who seeks to wreck production by creating belief in the public mind—particularly in the defense worker's mind—that the war effort is breaking down. He seizes any peg on which to hand his arguments. "American warplanes are inferior, cannot cope with the enemy." "American workmen are being brutally exploited by management." "Management is venal and unpatriotic." "The materials shortage is disastrous, cannot be remedied." This oral saboteur may be an actual enemy agent, or he may be an irresponsible gabbler—a show-off or a sorehead. The show-offs and soreheads are the welcome dupes of the Fifth Columnist. They spread his venomous propaganda while he stands by, chuckling. Considerable publicity has been given this propaganda. It is difficult to refute most of it without revealing production and other information which would be of great value to the enemy, disclosure of which would serve Axis ends almost equally with the production failure which the oral sabotage campaign seeks to induce.

We must present a united front to the oral saboteur and destroy him. He is our greatest enemy. The armies of the Axis can be brought down by the combined might of the United Nations, bolstered by the mass war production which only the United States can attain. American airplanes are the most efficient, most deadly in the world. That has been proved on every front where our equipment has come to grips with the enemy. Your daily newspaper tells you that. Our pilots are surpassed in ability by none. We have powerful allies. The Axis will be defeated, unless we permit the Axis to defeat us first in the battle of production, right here at home.

A study of this war makes it impossible to believe that air power will not be the determining factor. The first three days of the war alone, with their air-wrought destruction at Pearl Harbor and the ludicrous ease with which two huge battleships, the *Prince of Wales* and the *Repulse*, were sunk by aircraft, should attest to the significance of air power. So, all we have to do is get to the fighting fronts—*planes a' plenty in plenty of time*. That the air forces and the aircraft industry propose to do, and will do.

## America At War

(*Continued from page 71*)

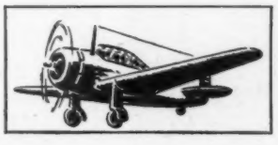
and possibly by taking some Japanese Islands. There are also the possibilities of operating from Alaska, of using Chinese territory when the Chinese and we can occupy areas close enough to Japan, and of using Russian ground if and when it is made available by hostilities. When we have absolute protection for our carriers, they too will be brought in close for attack.

One of our most serious problems is a plain old-fashioned shortage of experienced personnel. This is natural enough in a citizen army. We have experienced airmen, experienced maintenance men, but when you spread them, as nuclei among several hundred thousand new men, you are spreading them too thin. The result is exasperating delays and greenhorn plays aplenty, and there's nothing anybody can do about it. Nothing but time—a matter of months—can ease this situation.

Distance means everything in war. Both of the Axis powers are barricaded in their own back yards, with their guns and their shops and their grubstakes plumb handy. While the United States must spend the energy and the time and fuel and food to go four to eight thousand miles, and then fight after we get there. It's a tremendous job—a historial epoch; it's bigger than the movement of Europe's millions to the new world.

**NEW SUB-CONTRACTS: Fleetwings has recently taken on several additional sub-contracts . . . to speed "National Offense." For instance, Fleetwings is turning out *wings* for fast torpedo bombers, and *tail assemblies* for one of Uncle Sam's deadliest dive bombers.**

**MASS PRODUCTION of aircraft control surfaces is now ancient history at Fleetwings. Man-hours per set of control surfaces was again recently reduced 14% . . . thus increasing output . . . that is typical of records that are being set by Fleetwings' production workers. Every department in the plant continues to keep ahead of schedule . . . making 'em better and faster, whether they're huge wings and rudders for multi-motored bombers or hydraulic valves and jacks.**



**FAST WORKERS: One of the many reasons why Fleetwings can keep production ahead of schedule is that each employee's job has been simplified to an extreme—reduced to one or two operations. Another reason is that the Fleetwings Vocational School has already graduated about 1000 men . . . and these graduates are now helping to build warplanes and parts faster. Many women, too, are taking Fleetwings' *free* training course. And they also are making good.**

*"KEEP 'EM FLYING!"*

FLEETWINGS
*Incorporated*

BRISTOL • PENNSYLVANIA

And for that reason, we shall have to have three times as much shipping, three times as many airplanes, three times as much of everything as the enemy has, to beat him. That triple is not just a guess; it is the thoughtful estimate of our military leaders. For Allied individualists to buckle down and out-produce the enslaved hordes of the Axis is no small chore.

You recall that Donald Nelson, a few weeks back, said that our airplane production was up 50 percent over the rate at the time of Pearl Harbor. That was good news. But production has to go up about 350 percent before many swift months have rolled by, if we are to make the steep grade laid out by the President. We are in a steep climb, headed for the goal. It must be noted that the goal has changed, numerically, because of the shift to more heavy planes.

There is nothing the matter with our airplane production but human frailty in the face of such a task. We are still having bottleneck trouble—always shall. Bottlenecks exist everywhere, from little plants all the way up to big sheet of paper on which Donald Nelson every morning checks the industrial output of the United States. The different elements go up and down, like the planes in a formation flying rough air.

Right now, the aircraft industry is short of heavy dural forgings, and of many machined parts. Some plants have been waiting for engines. They are short of aluminum sheet. The forging shortage may be partly remedied by substituting castings. The machined parts will be speeded up by adding more subcontractors. But when our current bottlenecks are opened more will pop up.

A spectacular effort to beat the aluminum shortage has been started by several airplane producers, foremost among them being North American Aviation and Curtiss-Wright. N.A.A. is going over to wood and mild steel in its AT-6 trainer, believes combat ships too can be built without much aluminum. For over a year, N.A.A. has been working on a cold rolling process to get the right steel characteristics for the job. Other manufacturers have built steel planes; it is not new. But this mass steel production program is new, and it's important. It may turn out to be one of the high cards in the war deck.

You probably will ask yourself why, if steel can be flown now, it hasn't been done before. One answer is they didn't have the right steel. Another one is that ordinary steel corrodes, and may weaken at points hard to inspect. This problem is now solved by water-proof coatings. On the *out*side, the steel will be covered with camouflage paint anyway. Another answer, and this comes frankly from some of the best men, is that engineers have the aluminum habit, and are set in their ways. You can take that one, or leave it alone.

One of the prettiest things about steel is that all the wing and body surfaces will be spot-welded instead of riveted and the ship will be as smooth as any fish, except in wartime, when all planes are covered with camouflage paint, which is a bad drag.

Little is known of Curtiss-Wright plans to produce wood transport planes for the Army. Up to the close of the first World War, most airplanes were made almost entirely of wood. Then steel tubing was put into fuselages; then came Ford and other all-metal planes. There is no doubt about the success of the wood plane project. It's been done before; there are plenty of old timers skilled in wood design; new plants, such as furniture factories, can participate.

And to end this report with the tall story of the month. A Russian pilot bailed out, fell a couple of miles with an unopened chute, and hit on the side of a mountain so steep, in a snowdrift so deep, that he just ricocheted to the bottom, not badly hurt. It might be so—*might* be so, but. . . .

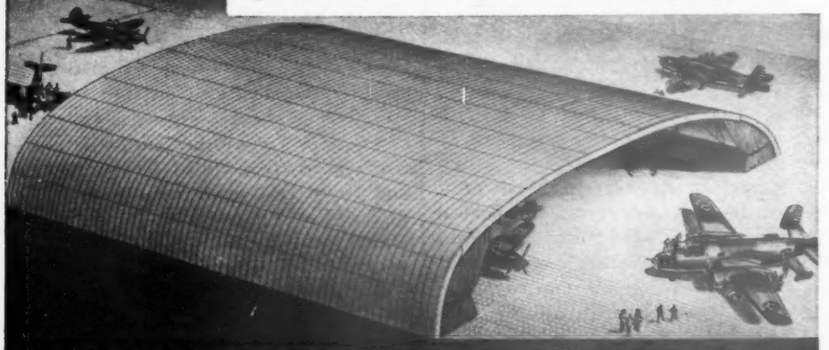
BUTLER READY-MADE STEEL BUILDINGS

**Where aircraft take off and land never was a place for tall buildings. Since the beginning of airfield development, Butler engineers have been building airplane hangars low to the ground to lessen obstruction to flight. Modern warfare uncovered still other reasons for "pancaking" airfield structures. The result is an entirely new hangar design—a radically different type of factory fabricated construction. About its details, we can here say nothing. Coming into its own now—it is a structure in step with the world's fastest developing industry—air transportation.**

**For over 30 years Butler Ready-made Steel Buildings have served in a score of industries. Before you build any structure, particularly any rated essential in the prosecution of the war, figure with Butler engineers. There are three helpful Butler Steel Building books.**

***For prompt handling, address all inquiries to:***
**1245 Eastern Avenue, Kansas City, Missouri, *or***
**945 Sixth Avenue, S. E., Minneapolis, Minnesota**

***Other sales offices:*** **Washington, New York, Chicago, Atlanta, Shreveport and Houston. Also representatives in other principal cities.**



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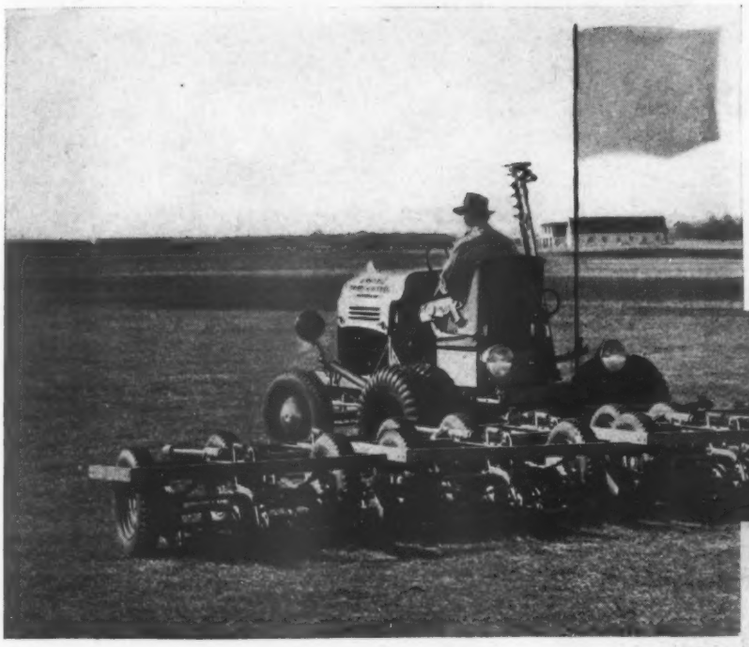
# Worthington
## AIRFIELD
## "Grass Blitzer"
### the only machine yet developed to solve your Airfield mowing problems



Note *frame* suspension of cutting unit and heavy steel protective skid.

Realizing that existing gang-mowers for park, highway and golf course use are inadequate for today's busy airfields, Worthington engineers have developed an entirely new type of gang-mower. Castors and rollers have been eliminated — only large pneumatic tires touch the ground and the height of cut is established by *suspension from the frame* instead of *from the ground up*. This enables the fast Worthington tractor to haul the 9-gang at 20 miles per hour, cutting 46 acres per hour, or 368 acres per 8-hour day. This is more than 400% greater capacity than the best of the present lawn or golf course type gang-mowers which can cut only 11 acres per hour or 88 acres per day when hauled at practical speeds that cannot exceed 6 miles per hour because of the heavy castor and roller "drag", and excessive vibration caused by these parts.

The high cutting speed of the "Grass Blitzer" enables it to keep out of the way of plane traffic. A short-wave radio receiver is available to enable the field control officer to direct its movements and eliminate the danger of collision.

In addition, frequent and regular cutting develops thick, dense turf which:

1. Keeps down dust which is a cause of too frequent motor tear-downs and parts replacements.
2. Helps eliminate hazards of loose stone, aggregate, gravel, etc., injuring propellers during motor revups, take-offs and landings.
3. Absorbs rainfall, preventing muddy areas and the danger of serious skids.
4. Helps eliminate wheel marks which can be photographed from as high as 30,000 feet.

Maintenance of Dispersion Fields is simplified by the "Grass Blitzer" Transport Trailer which enables the tractor element to haul the cutting units for immediate use when and where needed at highway speeds in excess of 30 m.p.h., eliminating the necessity of mowing equipment for each individual Airfield surrounding a Main Base.

Before purchasing old-style equipment it will pay you to investigate thoroughly the new Worthington Airfield "Grass Blitzer".

The "Grass Blitzer" Trailer on the Highway

**Tear out and mail this coupon, today,** *for handsome, illustrated catalog — "The Worthington Airfield 'Grass Blitzer' — A Study of Airfield Turf Area Grass Cutting and Maintenance Problems".*

**COUPON**

WORTHINGTON MOWER COMPANY
Dept. A/MY Stroudsburg, Pa.

Please send catalog giving details and specifications of the Worthington Airfield "Grass Blitzer".

NAME_____

ADDRESS_____

CITY_____ STATE_____

**WORTHINGTON MOWER COMPANY**

**MAIN OFFICE: STROUDSBURG, PA. • SALES AGENCIES • ALL PRINCIPAL CITIES**

Photo courtesy Lockheed Aircraft Corporation

# USE THIS NEW CAPACITOR DISCHARGE CONTROL

## —ON YOUR STORED-ENERGY WELDING MACHINES

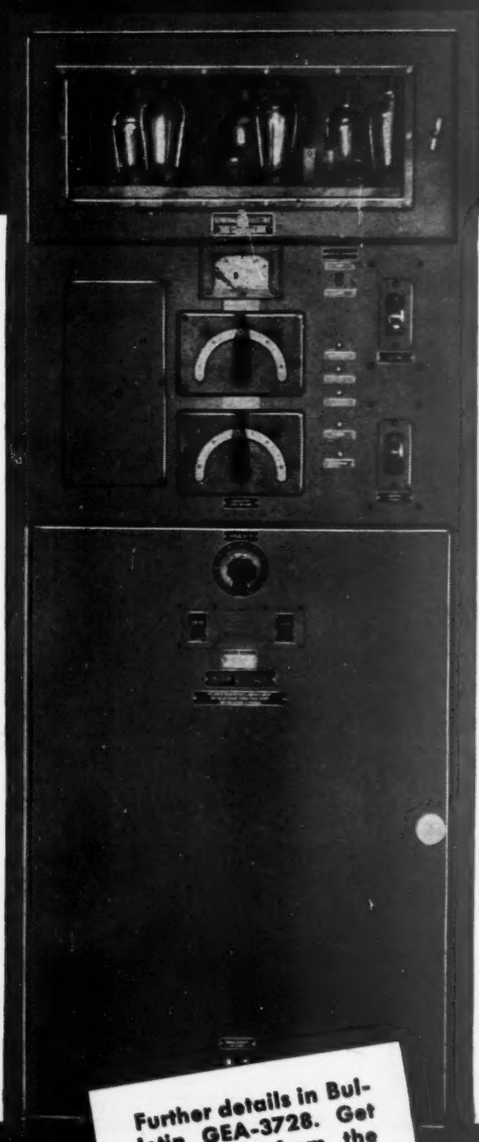
CONSISTENT values of current and timing, so vital to consistent aluminum-alloy welds, are assured when your stored-energy welding machines are equipped with a capacitor discharge control, one of G.E.'s newest developments.

Because of its low demand kva, this control also permits the use of a low-cost plant distribution system. Because of the low demand on the line, which means less voltage drop, you can economically install your welding machines at the most favorable places in your production line, even though the machine may be some distance from incoming distribution transformers.

Good voltage regulation afforded by the low demand kva also lessens the possibility of light flicker and limits interference with other welding equipment on the same circuit.

The time required for cleaning and dressing electrodes is greatly reduced with stored-energy welding. This is most apparent when welding heavy-gage aluminum alloys. Production is materially increased without compromise in weld quality, thus reducing rejects and boosting output and profits.

Designed by outstanding electronic engineers, General Electric's new capacitor discharge control is built for ease of installation and low maintenance.



Further details in Bulletin GEA-3728. Get your copy from the nearest G-E office. General Electric Co., Schenectady, N. Y.

GENERAL ELECTRIC

## Employee Thinking

(*Continued from page 75*)

it originated for an initial investigation. In addition, the members of a small Inter-Departmental Suggestion Committee are asked to consider each suggestion. Those to whom the suggestion is referred are asked to complete their investigation within not more than a week's time. If the idea is turned down, specific reason must be given for so doing—such as too costly, already adopted, etc. A review of the refusals is usually made by the supervisor of the suggestion system, to make sure that no good ideas have been inadvertently passed over. When the employee making the suggestion is informed of the fact that it has been turned down, he is invited to protest the decision if he cares to.

Suggestions which are accepted are turned over to cost control department for an estimate to determine the amount of saving effected. Awards for suggestions adopted are made on the basis of a payment of five percent of the amount saved during the first years of its adoption. There is a lower limit of $2 and an upper limit of $100 for awards. There is no limit to the number of awards made, all suggestions considered worth while are accepted.

Each employee who receives the maximum award of $100 automatically becomes a member of the RCA Century Club, and receives a free all expense trip to New York. In addition, his suggestion, together with other top award winners, is reviewed at the end of the year, for possible selections as the "best award of the year." If an employee has made several successful suggestions during the year, the awards for which total $100, that person is also eligible to receive the year-end award which is another $250 in cash.

Presentations for the awards are made with all possible appropriate publicity throughout the company. The smaller awards are made by the supervisor or foreman in the department, the larger awards are made by high ranking officials, up to the president. At the time of the award the recipient is asked if he is satisfied with the size of the award, and if not, there is a review to determine whether a correct decision has been made.

The measure of the success of the RCA system is seen in the fact that each year results in a further growth in the number of suggestions submitted by the employees, and greater amounts saved in production costs through these suggestions. In ten years the system has become an indispensable part of the RCA plan for getting things done.

Now with the tremendous pressure of war production, RCA is cashing in constantly greater dividends through its suggestion system. Not only are ideas sought which will result in economies and product improvements but there is need for every short cut which will speed the output of essential materials for the fighting forces.

Not only RCA, but the nation as a whole is benefiting from this employee suggestion system.

## Instrument Pilots

(*Continued from page 197*)

with a dual set of all instruments, radio apparatus, and flying controls, except that the rear cockpit does not have flap controls and landing gear actuating levers. A curtain which separates the two cockpits is kept closed during instruction, and separates the pilot from all forward visibility. Side windows in the rear cockpit may be screened for totally "blind" flight instruction.

Each ship is equipped, in duplicate, with four standard airline receivers and one transmitter, as well as an interphone system for communications between the instructor and his student. The four receivers include a long-wave radio range and traffic control unit, a company communications unit, a Z-marker receiver, and a separate receiver for direction finding work. Both manual and automatic direction finding is employed in the training program.

### TRAINING SHIPS USED FOR INSTRUMENT TESTING

A corollary use of these twin-cockpit Grummans has been found for accurate comparison tests of various makes of flight instruments and radio apparatus. With two makes of an instrument to be tested installed in the two cockpits, direct comparison is possible at all times under identical operating conditions. This latter feature is proving extremely valuable to PAA in testing new equipment.

Ward Davis' hard-working Grumman Widgeons are now being operated seven and a half hours a day each, seven days a week. Six pilot instructors are constantly at work, training groups to be expert pilots.

The course includes, in addition to routine instrument flight procedures, radio range and direction finding navigation, and instrument approach and landing, the latter being made in the metropolitan waters under conditions simulating faithfully instrument landing facilities at all PAA's Atlantic ports of call.


**How this Stainless Tubing BOOSTS War Production and CONSERVES Vital Metal . . .**

**in making parts for planes, tanks, machine guns, ships, etc. - -**

**FASTER FABRICATING**

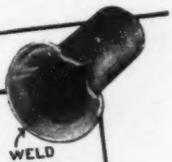
is possible with Carpenter Welded Stainless Tubing. Its ductility and uniform structure mean *easier* bending, cutting and welding. Expanding and flanging can be done *faster* with fewer rejects. As tubing shapes are natural design units, parts can often be finish formed by merely swaging, flanging, tapering, etc.—with a *minimum of machining.*

**METALS CONSERVED**

by using this tubing can be used to make *more* war machines and processing equipment. Scrap losses are minimized as this tubing is made from strip. Uniform wall thickness permits using lighter gauge tube. And *less machining* in your plant means *time saved* and *metals conserved.*

**PHYSICALLY,**

Carpenter Welded Stainless Tubing offers these advantages to designers, fabricators and users: a variety of Stainless types to meet specific performance requirements; high *resistance to heat and corrosion;* meets *Army* and *Navy* specifications; each length 100% *hydrostatically tested.*




**STRENGTH!**

This piece of tubing (from a regular production run) was flare tested to determine the strength of the weld. When the break occurred, it was AWAY FROM the weld. This tubing can often carry loads formerly supported by solid bars or heavier-walled tubing.

*IF you are an engineer doing experimental or research work, ask to receive our "Quick Facts" bulletins. They provide users of Stainless Tubing with tips to help speed production and make each length of tubing work harder. A note on your company letterhead will bring you "Quick Facts" bulletins.*

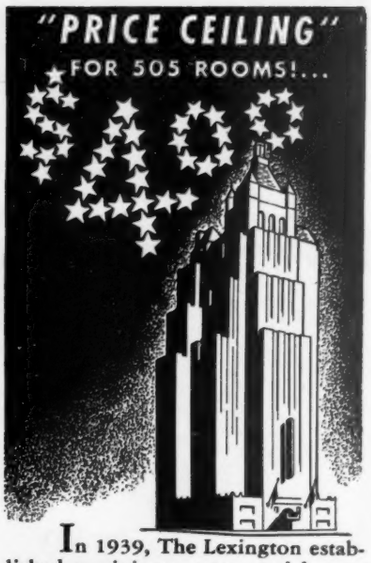
**THE CARPENTER STEEL CO.**

WELDED ALLOY TUBE DIV. KENILWORTH, N. J.

*Carpenter*

WELDED

STAINLESS TUBING




In 1939, The Lexington established a minimum rate—*and has not raised it since!* More than one-half the total number of rooms in the entire hotel are, now as before, priced at $4 . . . *all outside with combination tub and shower, circulating ice-water, full-length mirror and four-station radio.* Double rooms from $5.50; suites from $12 . . . at *"New York's Friendly Hotel."*

**Hotel Lexington**

Charles E. Rochester, Vice-Pres. & Mng. Dir.

**LEXINGTON AVE., AT 48TH ST., N. Y. C.**


| Table I | Resonance | Maximum amplitude |
|---|---|---|
| Angular velocity $\omega$ . . . . | $\varkappa = \omega_r$ . . . . . | $\omega_m = \frac{\varkappa}{\sqrt{1 - \frac{\lambda^2}{2\theta_B^2 \varkappa^2}}} > \varkappa$ [1] |
| Amplitude $\frac{m \cdot r \cdot d \cdot \omega^2}{\sqrt{(\varkappa^2 - \omega^2)^2 \theta_B^2 + \lambda^2 \omega^2}}$ . . | $C_r = \frac{m \cdot r \cdot d \cdot \varkappa}{\lambda}$ . . | $C_m = \frac{m \cdot r \cdot d \cdot \varkappa}{\lambda \sqrt{1 - \frac{\lambda^2}{4 \varkappa^2 \theta_B^2}}} > C_r$ |
| Phase $\epsilon$ . . . . . | $\epsilon_r = 90^0$ . . . . . | $\epsilon_m > 90^0$ |
| $\operatorname{tg} \epsilon = \frac{\lambda \cdot \omega}{\theta_B (\varkappa^2 - \omega^2)}$ . . . | $\operatorname{tg} \epsilon = \infty$ . . . . . | $\operatorname{tg} \epsilon_m = \frac{2 \theta_B \varkappa^2}{\lambda} \sqrt{1 - \frac{\lambda^2}{2 \varkappa^2 \theta_B^2}}$ |

## Dynamic Balancing

(*Continued from* 121)

nance frequency is equal to the natural frequency of the hypothetical undamped oscillation, the phase being at the same time 90 deg.

Special case 2. Maximum amplitude, Angular velocity[1] and phase are little greater than for resonance; see Table 1.

Numerical example. The resonance curve in Fig. 8 was obtained mathematically (broken line) and checked experimentally (unbroken line) by affixing, as shown in Fig. 8, a couple of

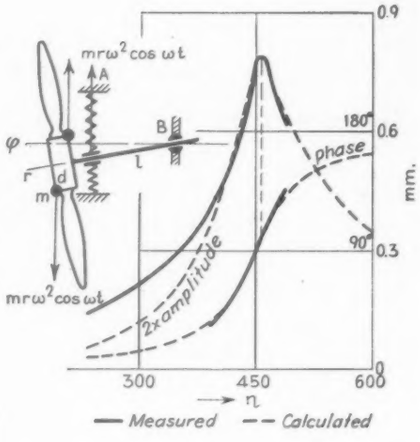



*Fig. 8. Coincidence between theoretically calculated and measured bearing oscillation in the range of resonance proves that the apparatus functions practically without friction and without aerodynamic disturbance.*

equal weights of 50 grams each to a balanced propeller, supposing an eccentricity of 1 m. Furthermore, in terms of kg., cm., sec. d = 24; l = 40; $2x_{max} = 0.079$; $\theta_B = 624 = f = 810$.

From this is obtained the

| | | |
|---|---|---|
| resonance angular velocity | $\omega_r =$ | 47.2 |
| resonance rpm. | $n_r =$ | 451 |
| damping constant | $\lambda =$ | 5950 |
| | $\lambda =$ | 0.1 |
| | | $2\pi\Theta\beta$ |

The maximum amplitude is only 0.5 percent greater than the resonance amplitude, the relative rpm. $n_m = 456$ being 1 percent higher than the resonance rpm. The insignificance of these differences is due to the greatly reduced friction and the high degree of coincidence between measurement and calculation to the reduced disturbing air currents, ie. to aerodynamic form.

[1] This optimal angular velocity deviates from the usual $\omega_m = \varkappa \sqrt{1 - \frac{\lambda^2}{2\theta_B^2 \varkappa^2}}$ because here the disturbing centrifugal forces are not constant, but proportional to

**A NEW ELECTRIC BOND TESTER**

~~MILLI-OHM-METER~~

~~MODEL~~

Ranges 0.5: 0.1: 0.05: 0.01: 0.005: and 0.001 ohms, at full scale

DOES NOT REQUIRE REFERENCE CURVES OR CHARTS . . . THE MEASURED RESISTANCE IS DIRECTLY READ FROM METER SCALE.

The battery-meter and controls are in the case . . . fixed clamp and exploring cables are easily connected.

Send for your copy of Bulletin No. B-5, details and prices are given. These low-resistance testers can be used by non-technical personnel.

**HALLCROSS MFG. CO.** COLLINGDALE PENNSYLVANIA

INSTRUMENTS • RESISTORS • SWITCHES

# For the Defense Program

# M-R-C
## ROLLER BEARINGS

*Special for*

**AIRCRAFT ENGINES**

# M-R-C ROLLER BEARINGS

Leadership M-R-C Sturdi SRB Quality ROLLER BEARINGS

**MARLIN-ROCKWELL CORPORATION**

Executive Offices: JAMESTOWN, N. Y.

Leadership M-R-C Sturdi SRB Quality ROLLER BEARINGS

# A BETTERMENT . . .

## *Not a Substitute*

The 1942 Scouting Plane is more than a substitute for the Observation Balloon of 1860.

The Scouting Plane is an advancement . . . a BETTERMENT!

And likewise . . . CONTINENTAL-DIAMOND NON-metallics are not substitute materials for corrosive, weighty, costly, and now hard-to-get materials. C-D NON-metallics possess unique characteristic combinations that make them ideally suited to meet many of the material problems of a war or peace economy.

Manufacturers who design to use C-D NON-metallics to the fullest measure of their capabilities will never go back to "Observation Balloon Days" . . . because they will have built into their products NON-metallic materials which are as modern as today's Scouting Plane.

A booklet describes all FIVE C-D NON-metallics. Ask for GF-12. Then, when you are ready to get down to brass tacks, write, wire or phone us about your problem . . . or ask us to send around one of our Research Engineers.

**Continental-Diamond FIBRE COMPANY**

*Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE*

## Underground Factory

(*Continued from page 76*)

and roofs were given a coat of yellow paint to prevent fine dust from falling upon and damaging high-precision machinery.

The workers, men and women, enter and leave by means of four elevators and two escalators. A shaft of exceptional size, topped by a powerful hoist, provides a means of lowering the larger machines into the underground factory and of raising out the heavier and bulkier items produced.

Although we in America have not yet had occasion to go underground in building our war industries, nor anticipate in the near future the necessity of planning to do so, it is interesting to see how the British are adapting themselves to subterranean manufacturing conditions. And while here in the United States we do not have chalk mines, we do have some rather extensive caverns, such as the Mammoth Cave in Kentucky and the Carlsbad Caverns in New Mexico, which run in some cases for more than a hundred miles deep underground.

## Remote Drives

(*Continued from page 85*)

but still well inside useful and practical limits.

For the immediate future, and particularly for simple distances and angles of transmission, it is probable that the direct mechanical drive will be easily available; for greater distances, and for more difficult installations and requirements, I think the hydraulic drive can be expected to turn up with practicable weight and efficiency.

To conclude: If we assume that the remote drive is an inevitable development, what is the best method of getting it under way? Nobody is going to start off with a large airplane of which the design depends on a transmission installation. So it would seem desirable to look for a class of airplane in which remote drive would be clearly and definitely beneficial. The small high-performance flying boat certainly fills that bill and, since we could well employ such a machine if we had one, it seems a good line on which to start.

## Radio

(*Continued from page 177*)

wall thickness of tubing drawn over such wires. Also included is more conventional data such as the number of strands in the wire core, resistance-per-foot in ohms and voltage breakdown.

## AIRACO Personnel

Randolph C. Walker, president of the Aircraft Accessories Corporation, announces the following promotions and transfers:

D. C. Andress, formerly in charge of Airaco's estimating and tool design at Burbank, has been made works manager for the firm's Kansas City division. Dr. Charles N. Kimball, nationally known authority in electrical and radio engineering, has been made executive engineer and technical advisor to Mr. Walker.

A. D. Vollenweider, former assistant chief engineer, becomes chief engineer at Kansas City. William J. Hosmer, secretary of the corporation, has been moved from Burbank to Kansas City, where he will direct production planning activities. Robert S. Van Cleve moves from Kansas City to Dayton, Ohio, where he will be in charge of government sales and contracts.

Aircraft Accessories Corp., has greatly expanded its aviation business.

## More Switches, Relays

Makers of sensitive electrical and electronic control devices have been as busy as the proverbial paper-hanger designing equipment to meet rigid wartime aircraft requirements. Progress has been particularly rapid in connection with switches and relays and the crop of these continues to mount with increased aircraft production.

The Mu-Switch Corporation of Canton, Mass. recently designed a switch to meet the requirements of Air Corp. Spec. 94—32249, now announces that tests verify the conservatism of a 25 amp., 28 v., d.c. rating for altitudes up to 40,000 ft.

Struthers-Dunn, Inc. of Philadelphia has a new mechanical latch-in, electrical reset relay designed especially for aircraft use and tested to withstand vibration incident to such use. The relay, type CX3190, operates from a brief impulse without the necessity of keeping the coils energized. Double-pole, double-throw contacts are rated at 6 amps. at 12 or 24 v., d.c. An auxiliary contact breaks one coil circuit. All contacts are insulated from the frame for radio frequency service.

ARMY TWILL
BY
REEVES
SANFORIZED*
MADE TO GOVERNMENT SPECIFICATIONS
REEVES
Glengarrie
POPLIN
For Better Uniforms
Demand These Labels!
REEVES ARMY TWILL
SCORES A HIT!
With pilots, ground crew and passengers alike, uniforms of Reeves Army Twill are way ahead in popularity. They're neat in appearance—long on wearing qualities! So specify this famous fabric when ordering your uniforms.
Reeves Army Twill passes U. S. Govt. tests for strength, endurance and color-fastness. For fabric vitality it's a leader!
For matching shirts, GLENGARRIE POPLIN is equally popular. Both fabrics available in favorite colors — are Sanforized* against shrinking.
*Fabric shrinkage not more than 1%. (U. S. Government Test CCC-T-191-a)
See your nearest dealer for uniforms, sport and work clothes made from these famous fabrics, or write for leaflet to:
OVER 50 million yards of Reeves Army Twill sold to the U.S. ARMY
REEVES BROTHERS, INC.
54 WORTH STREET
NEW YORK CITY

## Airplane Plant Design

(*Continued from page 97*)

Today, with work carried on 24 hours a day, the cost of artificial lighting may be inconsequential. But with the return to the normal eight-hour day, this may prove a handicap, especially in meeting competition later. The cost of necessary air-changing and cooling may actually prove prohibitive.

Most of our clients, and especially those expecting to operate their new plants after the war, have preferred the daylighted plant with provision for blackout when needed. This, incidentally, is easily taken care of.

Mostly, the design of the blackout facilities has called for the welding of clip angles onto the vertical mullions between the sash in both the sidewalls and the monitors. The clip angles are drilled so "two-by-fours" can be quickly bolted to them. Metal sheets can be easily attached to the two-by-fours. Thus all light can be kept within the plant after darkness falls.

### SINGLE UNIT PLANTS

Years ago Henry Ford advanced the theory that utmost efficiency in industrial production could be achieved only if a plant was, in the main, under one roof. He insisted that segregated buildings were detrimental; that, on the other hand, a large manufacturing area under one roof, with a minimum number of walls and generally only one story high, made for easier supervision and more economical operation.

That his contention was right is amply proven by the fact that most new manufacturing plants today are one-story structures, with occasionally a second floor for certain departments or operations. While the mammoth, one-story manufacturing unit is not precisely an innovation, it is being adopted almost universally by the growing aviation industry.

Vast, unobstructed areas of floor space characterize the new aviation plants, particularly those engaged in turning out bombers and a variety of other fighting aircraft. It's quickly apparent that clear floor space, unbroken by obstructions, is an especial requirement in this form of manufacturing.

In one particular building of a large Eastern manufacturer this concept reaches a new high. The structure is 300 ft. wide and 700 ft. long. The entire floor space is unbroken by a single column. Made light as possible, the roof is supported by bridge trusses—the longest flat spans in the world. Since there are already bombers that measure 212 ft. from wing tip to wing tip, it is easy to see that this huge structure is none too wide.

Column-spacing is an important consideration in any plant designed for maximum efficiency in mass production. Every column loses not less than four square feet of floor space, counting the useless area immediately surrounding it, and every added column interferes just that much with the economical placing of machine tools and also obstructs the flow of materials. By careful study and design, architects and engineers have been able greatly to increase distances between columns at little, if any, additional cost.

## Side Slips

(*Continued from page 175*)

been, the air-cool realm of knowledge has been built up so much recently—it has brand new possibilities on the road.

Another thing we are for is transparent plastic tops that fold down. Or metal, if you'd feel like a goldfish. A closed-hardtop-convertible car in one is what we mean. We've got it on planes already; just adapt it to cars.

A light aluminum road job, with no paint, no water, no rust, and a load of aeronautical style is what Batten, Barton, Durstine and Osborn and the people are waiting for. Send $1 for membership in the Side Slip to Cars Movement.

## Maintenance

(*Continued from page 189*)

position, with perfect reliability. This system has worked out well enough so that at the present time there is only one licensed A. and E. mechanic at Hawthorne for every six A airplanes.

Below the licensed mechanics are the army rated men, known as Civilian Air Mechanics, who have been rated by the Army as qualified to work on any particular type of airplane, in this case the PT-17. These men receive these ratings only after six months' experience and after passing a rigid written examination, based on complete manuals on the airplane and engines and other texts supplied by South East Air Corps Training Center. A practical test is also required to gain this rating. The present ratio is one Civil Air Mechanic for every three airplanes. Below these men

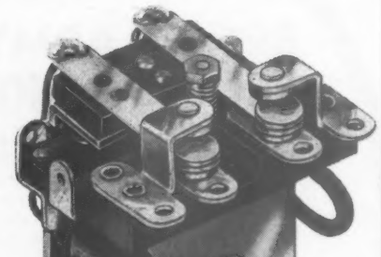

**ALLIED** PRECISION BUILT
**AIRCRAFT RELAYS**

ALLIED offers a new line of aircraft relays of unique design, ranging from small miniature relays to power type relays with a rating of 100 amperes at 24 Volts D.C. Contacts range from single pole single throw to six pole, double throw. The line also varies from power relays to highly sensitive units.

This line represents many years of intensive development work resulting in important features such as, compactness, light weight, minimum base mounting area, and easy availability of contacts for connections.

These relays have been tested and approved for many important new aircraft applications where resistance to vibration, wide temperature variations, resistance to corrosion, and low wattage operation are essential.

Allied offers precision manufacturing, highly skilled and specialized testing, and above all, reliable and competent manufacturing.



Type AO
Patent Applied for

Inquiries from aircraft and other designing engineers will receive prompt attention.

**ALLIED CONTROL COMPANY, INC.**
227 FULTON STREET NEW YORK CITY

*Built by the Langley Aircraft Corporation of New York, this 4-place twin-engined "Langely" plane uses Catabond #590 for all integral structural members and wherever motor heat might directly affect the bond.*

***Catabond #590,*** a thermosetting resin glue of high molecular ratio, has been developed to fill a vital gap in the requirements of the rapidly growing aircraft industry. This resin cures permanently at 140°F. and produces uniform, dependable joints of typical phenolic resin performance.

***In the autoclave processes,*** the development of Catabond #590 is of special significance. Previous phenolic resin formulae required curing in temperatures above 230°F., causing the rubber bags used in these processes to deteriorate quickly. Because of the new, low temperatures employed, their life can now be extended greatly.

***However,*** other possibilities are now open. Large, easily constructed insulated rooms maintained at 140°F. and in which humidity could be readily controlled to maintain wood stability, offer distinct advantages for curing plane assemblies glued with Catabond #590. Mixing, handling, spreading and clamping properties are almost identical with those of casein glue.

***A long series of comparative tests,*** conducted at the Bellanca Aircraft Co., have definitely proven the superiority of this resin over other types of bonding mediums used in aircraft assemblies.

***Glue lines with this resin*** are stronger than the wood itself . . . shear tests on 3 sq. inch blocks Birch to Birch, have averaged 2772 lbs. per sq. in. parallel to the grain and 1059 lbs. per sq. in. perpendicular to the grain. Other tests in which alternating cycles of 8 hrs. in boiling water, 8 hrs. in cold water and 8 hrs. of drying for 8 days were conducted. The specimens were manually destroyed and no evidence of joint failure could be found. 4 ft. panels of typical wing construction were immersed in a tank of boiling water for a day, then oven-baked to develop violent shrinkage stresses. Catabond successfully resisted the stresses. Test panels were exposed for a year, moored to a roof, without any ill effects . . . panels with other glues, similarly tested, collapsed shortly after being exposed.

***"Catabond" hot, intermediate and cold-setting liquid phenolic resin formulations are employed in glueing, bonding, impregnating, compregnating and molding wood, plywood, abrasives, sisal, cork, canvas, fibre, etc. New adaptations are constantly being developed by Catalin engineers and chemists to meet the individual requirements of industries and manufacturers. Your inquiry is invited!***

**CATALIN CORPORATION • ONE PARK AVENUE • NEW YORK, N.Y.**

THE *Catalin* FAMILY
OF MODERN PLASTICS

*Catalin** AND *Prystal**
CAST PHENOLIC RESINS
TECHNICAL CAST RESINS

*Loalin**
POLYSTYRENE MOLDING COMPOUNDS

*Catabond** AND *Catavar**
MELAMINE AND PHENOL-FORMALDEHYDE LIQUID RESINS

*Registered Trade Mark

# FIT TO FLY

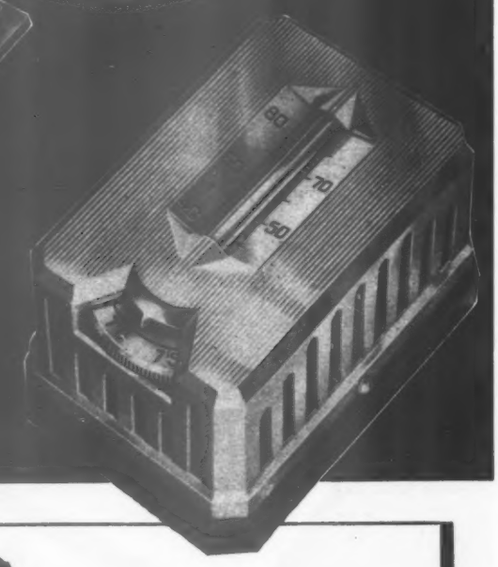
## Klixon Aircraft Controls

C-4351 THERMOSNAP SWITCH—One of many non-adjustable types. Large number of settings available. Immune to shock and vibration.

TIME DELAY RELAY—Time delays as high as 2 minutes, operates in any position. Light and compact—not affected by altitude, shock or vibration.

B-3120—Small thermostat and resistance heater in combination. Used to maintain temperature of small instruments and devices.

CABIN CONTROL THERMOSTAT—Close differential—adjustable range—not affected by altitude, shock or vibration.



Klixon controls are air-minded. They have the qualifications that make them practical for planes. They are light-weight, small, compact, simple, sure, shock-proof, vibration-proof and not affected by high altitudes or ambient conditions. They are activated by a scientifically calibrated thermostatic disc that is positive and snap-acting in operation. They contain no solenoids, toggles or other fussy parts that add bulk and weight.

Klixon Controls have earned their wings. All of them have been flying in planes—both military and commercial—since long before the war. Send for complete information on any or all of them.

### KLIXON Aircraft Circuit Breakers

These breakers—push button and toggle types—are available in ratings through 120 amps. They have high rupturing capacities—are light in weight—and give complete foolproof protection to aircraft circuits. Send for bulletins containing complete data.

KLIXON
TRADE MARK REG. U.S. PAT. OFF.

*Spencer Thermostat Co., Attleboro, Massachusetts*

**MANUFACTURERS OF THERMOSTATS AND TEMPERATURE CONTROLS FOR AIRCRAFT CABINS, RADIOS, ENGINES AND INSTRUMENTS**

are the apprentice mechanics and the line crews. The use of correspondence courses in aircraft mechanics has been found quite successful in training inexperienced personnel. Under a cooperative, school sponsored system, over a dozen Hawthorne ground personnel have taken such course with marked results.

The maintenance crews at Hawthorne come under the more correct terminology of inspection crews. This is true mainly because of the nature of the maintenance work which the army permits contract schools to perform. There are three classifications of maintenance known to the army—first, second and third echelon maintenance. Third echelon is work of a major nature including major wing or fuselage repair. Second echelon is minor repair such as ribs, small members, minor motor overhaul work; first echelon maintenance is simple work which is actually done while a plane is still on the line and in serviceable condition. Schools such as Hawthorne are permitted to do only first and second echelon work leaving major airplane and engine work to regular Air Corps Repair Depots.

Thus in many respects the term inspection applies more aptly to the maintenance section of Hawthorne. The structure of the maintenance set-up is as follows: The crews are divided into two units working two different shifts. At the head of each shift is an inspector who is directly responsible for the condition of the airplanes. Under the inspector is the Hangar chief, who acts as shop foreman. Under each chief, one for each shift, are the inspection crew and line crew; the inspection crew handling the maintenance and the line crew handling the servicing, parking, warming of airplanes during flight periods. Shift No. 1 works from 4:00 a.m. to 12:30 p.m. while No. 2 shift comes on at 12:00 noon and quits at 8:30 p.m. The half hour overlap when both crews are on the job, enables the second shifts to pick up their work smoothly from the first crew.

In addition to these crews there is a hangar crew which is more or less the trouble shooting, utilitarian outfit which takes care of emergencies. This crew is made up of the best mechanics and workers. It is their duty to handle any minor damages such as bent ailerons, patches, replacement work and engine changes in a fast efficient manner which will get any particular plane back on the line immediately with a minimum loss of time. This system avoids the necessity of breaking into the routine of the inspection crews as they handle the regular maintenance work required on all the ships.

A brief study of the maintenance methods and standards as set up by the army will give some idea of why such a well organized and efficient, as well as large inspection force is needed. When one realizes that each PT-17 is given an inspection, at each 50 hr. period, more severe than the *annual* inspection given a civilian plane, a fair idea of the thoroughness of the work is gained. This is doubly significant when it is realized that the average Stearman rolls up 50 hr. in less than two weeks time.

Here briefly is the schedule of inspections which any particular plane at Hawthorne undergoes. Each morning the ship is given a preflight inspection which consists of visual inspection of all controls, fittings, and draining of all sumps and fuel strainers. The engine is warmed to proper temperature and magnetos checked. It is, as the name implies, the ground or preflight check made before the airplane leaves the ground for the day. After each flight, members of the ground crew give the airplane a routine check, in which the propeller blades are inspected for any dents or cracks which may have developed during flight. At night, after the day's flying is done the airplane gets a daily check which is more thorough than the preflight. In this inspection all surfaces are inspected for holes, the plane is wiped down, fittings checked. The cowling is lifted, engine installation inspected along with tire inflation and condition of landing gear, and tail wheel assembly.

At the end of 25 hr. the plane gets a more thorough going over. All cowling and inspection plates are removed. The plane is completely washed down and inspected. The ship is lifted off its wheels and the landing gear completely inspected, checked and greased. Carburetor strainers are taken off and cleaned, engine controls thoroughly checked. It takes two to three men about 4 hr. to "pull" this type of inspection.

At the 50 hr. check, the wheels are removed and inspected, brakes cleaned and checked. Every fairing and all wing plates are removed for thorough inspection inside as well as out. Every fitting and member is thoroughly and completely scrutinized in this check. Oil is also changed at this period. A crew will take 6 to 8 hr. on such an inspection.

It might be added that the careful engineering of the Stearman from a maintenance point of view makes possible such short yet complete inspections. Like all training planes built for the Army, every fundamental and important part of the airplane can be readily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reached through quickly detachable cowlings. For instance, the sides of the fuselage near the cockpit are nothing more than quickly removable metal cowls making possible instantaneous inspection and simple work, on throttle arms, instruments, controls, etc. The entire bottom of the front seat cockpit drops off allowing a mechanic to stand upright, head and shoulders into the cockpit, to work on controls, instruments, etc. Elsewhere in the airplane equally accessible inspections are possible. Such inspection provisions are a revelation when comparison is made with civilian aircraft and these methods of construction will undoubtedly leave their mark on future aircraft production for commercial flying.

At the 100 hr. and 200 hr. marks, the same rigid 50 hr. inspection is repeated again, but with more attention to the engine. At 100 hr. the spark plugs are replaced with new or reconditioned ones and at 200 hr. the cylinder hold down nuts are torqued. It is interesting to note that up to this writing, over 17,000 hr. have been put in on the Continental engines at Hawthorne and so far not one cylinder has had to be removed because of stuck rings or valves. During this same period there have only been two forced landings directly or indirectly attributable to the engines.

At 550 hr. the engines are normally changed, but if the power plant is giving satisfactory performance at this period its time before overhaul may be increased by 20 percent. Using a chain hoist and a special stand which mounts an engine already for installation, an engine change over can be done in 3 hr. with two men. Since major engine overhaul comes under third echelon classification engines are shipped from Hawthorne to regular Air Corps depots for reconditioning.

Such is the rigid and thorough treatment given to training planes used at a typical civil elementary school. To keep an entire fleet of planes going with a minimum amount of delay is an understandable headache for any man. And, in this game inspections just aren't put off. Planes are given their periodical inspections within an hour of the time they are due. Careful planning and scheduling of checks is obviously necessary. During the last few months this has been worked out so that on the average less than 10 percent of the entire fleet of training planes is laid up at any one time for inspection and maintenance.

There are a number of problems which arise to make the role of maintenance superintendent a hard one. Oddly enough one of the greatest delays results from delay in getting parts. This is not at all a reflection on the Air Corps set-up but one attributable mainly to the rapidly increased training schedule. This situation is rapidly becoming overcome as time goes on but has, at one time or another, resulted in extensive temporary delays. For instance over 50 percent of the planes at Hawthorne were tied up at one time for lack of tail wheel control cables. This was finally licked by splicing up new cables right in the Hawthorne shops. Many of the parts delays have been due to slow transportation facilities. In recent weeks the Civil Air Patrol has delivered a number of rush shipments to Hawthorne Field which have saved several days tieup, in getting ships back on the line. Army Air Corps officers stationed at the field are enthusiastic over this method of delivery which is definitely a worthwhile function for CAP members and probably could be greatly expanded if fully appreciated.

Another problem at Hawthorne which has called for special handling is that evolving from operation on extremely sandy fields and flying in dusty conditions. Particular attention must be paid to this ever present menace. Landing gear and tail wheel assemblies are constantly in need of attention for this reason. The strainer in the carburetor airscoop is cleaned and re-oiled every other day, a factor which is believed adds greatly to the life of the engines. To insure that the airplanes are properly cleaned for thorough and complete inspection, much attention is paid to cleaning and the airplane is thoroughly washed down before all but the daily inspections. The cleaning mixture used is a 50-50 mixture of kerosene and white gasoline atomized through a regular cleaning gun and sprayed on metal parts under high pressure. The fabric is cleaned with a special Army Specification soap mixed with water. The monthly cleaning bill at Hawthorne is a shade more than $500 but, to quote Sam Monschke, its worth it: "A clean airplane is a well maintained airplane."

During the course of developing a maintenance and inspection system at Hawthorne which would work smoothly a number of new systems, methods and tools have been devised. In particular, the improvisation and development of special tools and gadgets has been of interest. As would be the case in any other well organized maintenance shop, many special small tools have been developed to speed work. For instance a special wrench was developed in the Hawthorne shops for expediting carburetor changes.

Other devices are interesting also. The previously mentioned dust problem in South Carolina works havoc in particular in the brakes where the dust particles get inside the mechanism and need constant attention. Since it is an

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hydraulic system, every time work is done the lines must be bled, usually a long and slow process when one man has to pump the brake pedals and another operates the bleeder valve. Borrowing a tip from automotive practice, an hydraulic bleeding pump has been devised which enables one man to perform the operation 50 percent faster.

Another servicing problem which has called for local ingenuity is a portable type compressed air chamber of extremely high pressure for landing gear service. The tail wheel on the PT-17 contains an Aerol strut which is subject to atmospheric and temperature changes to a marked degree. For instance, a ship's tail wheel shock strut may be in proper conditions at mid-day, only to sag by night because of changed air and temperature conditions. Air at around 400 lb. pressure is needed for such a purpose. Monschke has worked out a gadget consisting of an old Heywood compressed air engine starter, used as a booster pump, and an old Heywood air tank which is portable and can be used to carry air at these high pressures to the airplanes on the line for servicing the faulty struts immediately. By using this device, it is unnecessary to take a ship off the flight line.

Because of an army regulation against the use of step ladders around the airplanes for servicing work, all engine work, etc., is done from specially built stands with folding second decks on them, which can be used when work of an extremely high nature is necessary. These in general follow the usual practice of servicing stands, being light welded steel tubing on casters for quick moving.

In addition to the already mentioned devices and methods of servicing a large fleet of training planes, there are, of course, other phases of this operation which space does not permit us to go into. There can be little doubt that this maintenance is as thorough and as complete as any system could be. That the safety record of the Primary Training Program is as good as it already has been is a tribute in many respects to the fact that the planes are getting this type of unrelenting inspection and service.

Since this article is intended to deal primarily with details of routine, procedures and methods used at Hawthorne, little mention has been made so far of the work which the Army personnel at Hawthorne does in conjunction with the civilian crews. There is a regular Air Corps Engineering Office at Hawthorne headed by Capt. J. B. Wallace, which supervises and directs the entire maintenance operation. Tied in with this is also the function of the supply officer, First Lieut. Robert Stivers who must coordinate the dispatch and arrival of all necessary spare parts to avoid a minimum of delay. A regular engineering inspection by army technicians is required on every airplane at Hawthorne once a month in addition to the regular inspections run by the civilian crews. There are known as post inspections. Actually, one of the several Sergeants from the Engineering Office gives each airplane a thorough inspection at the conclusion of each regular 25 hr. check.

To keep all the records of the flight activity of the airplanes and the maintenance work done, two clerks are employed by the maintenance department for this work alone. The daily records of each ship's flying even including the names of the pilots, is kept on large sheets for constant reference. As a visual guide to keep the inspection crews advised of approaching check periods for the various airplanes, large blackboards revised every day, list the total time on each ship, when inspections are due, and noting any special work needed on that particular ship.

As a classic and concluding example of this thoroughness, it might be mentioned that even the Medical Corps has its part to play in keeping the planes fit. After much consultation between the post surgeon and the maintenance department, even the speaking tubes, used for communication between instructor and student are sterilized and cleaned at regular and frequent intervals!

## Transition Trainers

(*Continued from page 201*)

The problem was solved, not by a military, but by a commercial aircraft manufacturer. In 1939, the Cessna Aircraft Company at Wichita had developed a medium-weight, high-performance, twin-engined cabin monoplane known commercially as the Cessna T-50. Equipped with a retractable landing gear, flaps, and two Jacobs 225 hp. engines, it was ideal as a transitional multi-engined trainer. In addition, it was of welded steel tube and plastic construction, fabric-covered, and could readily be produced in quantity because these materials were easily obtainable and simple of fabrication.

The first military adaptation of the T-50 was the AT-8, a quantity of which were purchased by the then U. S. Army Air Corps for service tests. The model was powered with 280 hp. Lycoming engines, and had an automatic pilot and complete instrument and radio equipment installed.

Next came the Cessna *Crane*, so named by the Royal Canadian Air Force. It was Jacobs-powered, with


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changes that included special provisions for the sub-zero operating conditions encountered during Canadian winters. The success of this aircraft in its wartime role is best shown by the fact that hundreds and hundreds of Cessna *Cranes* are in use for training pilots sent from all parts of the British Empire. It is the only American-built twin-engined trainer being used in the British Commonwealth Air Training program and as a result, Cessna has built more twin-engined advanced trainers than all other U. S. manufacturers combined.

Newest Cessna bomber-pilot trainer is the *Bobcat* (AT-17) being supplied in quantity to the U. S. Army Air Forces. Among other companies manufacturing twin-engined trainers are Curtiss-Wright with their all-metal AT-9 and Beech Aircraft, who offer the AT-10, a composite metal and plywood model, both types being supplied to the U. S. Army. These planes, as well as the Cessna *Bobcat* are being used for multi-engined familiarization, advanced instrument instruction, navigation training and night flying.

With these new transition trainers, whose initial and operating costs are from one-third to one-fourth that of the combat types formerly used, the prospect is considerably brighter for training pilots and crews for multi-engined airplanes in sufficient numbers to keep up with the constantly increasing demands of our great Air Forces expansion program.

## Westland Whirlwind

(*Continued from page 203*)

speed de Havilland propellers is 10 ft., and the pitch range 20 deg.

The wing is built in three parts: a center section which carries the engine nacelles, and two outer panels which taper rather sharply on the trailing edge, and moderately on the leading edge, to the rounded tips. The center section, like the tail planes, has no dihedral, and only moderate dihedral is found in the outer panels. A turn-over bulkhead is provided in the cockpit frame.

There is a great similarity in appearance between the *Whirlwind* and the de Havilland D.H. 88 *Comet*, which won the MacRobertson Trophy Race to Melbourne back in 1934, except that the *Comet* had a normal tail structure. The *Comet*, slightly smaller, had a loaded weight of 5,550 lb., but was powered by lighter D.H. *Gypsy-Six* engines of 224 hp. each, and was of wooden construction. The two *Peregrine* engines used on the *Whirlwind* have a total dry weight (without hubs or starters) of 2,212 lb. Displacement of each is 1,297 cu. in.

Specifications and performance figures released on the *Whirlwind* powered by Rolls-Royce *Peregrine* engines of 860 hp. each are:

| | |
|---|---|
| Span | 45 ft. |
| Length overall | 31 ft. 6 in. |
| Height | 11 ft. 7 in. |
| Maximum speed | 353 m.p.h. |

## Charting Stability

(*Continued from page 125*)

of longitudinal motion. One of these is of short period with heavy damping. It is called the "short period" mode and is not very troublesome because of its heavy damping. The second mode is of long period and in this case has slightly negative damping. This is known as the "long period" mode or as it is sometimes called, the "Phugoid" mode.

Regions of the basic chart in the neighborhood of these solutions were extracted and blown up in scale for more accurate plotting of their variations. The short period mode is shown in Fig. 2, while the long period mode is shown in Fig. 3.

The problem now is to try to take this dynamically unstable airplane and make it stable. To do this, variations in basic parameter are carried through and the effects on the motion traced on the chart. The following variations were made:

$C_L$.... .2, .4, .6, .8, 1.2, 1.4, 1.6, 2.0
$C_{D0}$. .. .016, .018, .022, .026, .030, .040, .050
$R$..... 5, 8, 10, 12, 14
$x_{ac}$ . .. +.15, +.10, +.05, 0, −.10, −.15, −.20, −.25

$\frac{S'}{S}$..... .05, .10, .15, .20, .25

$l$. .... 16, 18.4, 21.6, 24.0, 28.0
$k_y$..... 14, 12, 8, 6, 4

The traces of variations of solutions for variation of each parameter are shown in Figs. 2 and 3. The effect of each parameter change on the two modes will be discussed.

**1. SHORT PERIOD MODE:**

(b) Variation of $C_{D0}$—Variation of lift coefficient has little effect on the non-dimensional period, but as an increase in $C_L$ means a drop in speed and thereby an increase in the time constant the period in seconds will increase with $C_L$.

(b) Variation of $C_D0$—Variation of parasite drag coefficient has such a small effect on the short period mode that the variation cannot be shown on the chart.

(c) Variation of $S'/S$—Increasing the horizontal tail area reduces the period and improves the damping.

(d) Variation of "1"—Increasing the tail length has the same effect as $S'/S$—decreasing the period and improving the damping.

(e) Variation of $k_y$—Increasing the moment of inertia about the lateral axis lengthens the period and reduces the damping in direct opposition to $S'/S$ and "1".

(f) Variation of Aspect Ratio—Increasing the aspect ratio reduces the period and improves the damping up to a certain point. It is not as effective as $k_y$, $S'/S$ or "1".

(g) Variation of $x_{ac}$—Moving the c.g. forward tends to shorten the period but has no effect on the damping. The short period mode is very sensitive to change in the c.g. position.

**2. LONG PERIOD MODE:**

(a) Variation of $C_L$—The lift coefficient has a very important effect on the long period mode. The variation of the solution with $C_L$ shows that the motion will be stable at low lift coefficients and will be more unstable at high lift coefficients. Airplanes all tend to be stable at low lift coefficients so any test for dynamic longitudinal stability should be done at as high a lift coefficient as is necessary to meet stability requirements. The specific effect on the motion of increasing $C_L$ is to decrease the damp-

*In this flight view, the interesting tail unit is clearly seen.*

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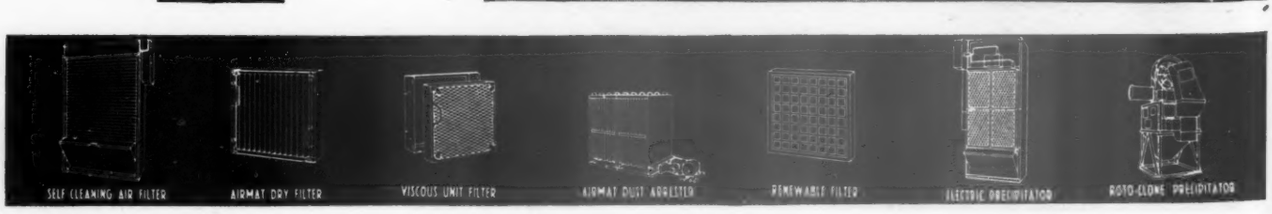

ing and shorten the period. The period shortens in non-dimensional units considerably, but as the time constant is increasing with $\sqrt{C_L}$ the reduction is not as great as it might seem.

(b) Variation of $C_{D_0}$—Increasing the parasite drag of the airplane will tend to make the airplane more stable. The effect on the period is negligible, but a "dirtier" airplane will always be more stable.

(c) Variation with $S'/S$—Increasing the horizontal tail area has little effect on the period but improves the damping considerably.

(d) Variation of "l"—Increasing the tail length also has little effect on the period but improves the damping to a greater degree than $S'/S$.

(e) Variation of $k_y$—Increasing the moment of inertia about the lateral axis has a negligible effect on the period of this mode, but has a very important deteriorating effect on the damping. It is necessary to reduce the moment of inertia to get better damping. The negligible effect of the moment of inertia on the period seems hard for many to believe. Their difficulty lies in their attempt to picture the problem as a system in one degree of freedom, whereas it is the more complicated one in three degrees of freedom.

(f) Variation of Aspect Ratio—The effect of variation of aspect ratio on this mode is rather small. Either decreasing or increasing the aspect ratio of this airplane tends to shorten the period somewhat, whereas an increase in aspect ratio makes the damping more negative.

(g) Variation of $x_{ac}$—Moving the c.g. to the rear tends to lengthen the period, while moving it forward shortens the period up to a certain point. The effect on the damping of c.g. position is the most interesting. As the c.g. moves to the rear, the damping at first gets more negative, then after about $x_{ac} = +.04$ the damping improves with rearward c.g. position. As the c.g. is moved further and further back the damping keeps on improving and the period keeps on lengthening until the solution moves out of the oscillatory boundary and crosses over into the divergent region at an $x_{ac}$ of about $+.11$. One of the roots then becomes a pure divergence which is recognized as static instability divergence. As the c.g. moves forward from the starting assumption, the damping keeps on improving until $x_{ac} = -.15$, at which point the motion becomes stable.

To sum up, there seems little need for any design changes in the assumed airplane for improvement of the short period mode. This mode is very heavily damped in all cases and is not worth worrying about. To improve the airplane as far as the long period mode is concerned, it is necessary to move the c.g. range to the rear or more forward as either one will improve the stability range. Making the tail longer and larger as well as reducing the moment of inertia about the lateral axis would all improve the damping. Increasing the drag of the airplane would of course be beneficial to the damping, but this is one parameter that is not usually allowed to be changed in this manner.

It is necessary to point out that the changes in the dynamic longitudinal motion are for this particular airplane and must not be construed to be perfectly general. The effects are general in a qualitative way in that they show the general effect of these parameter changes.

It can be seen from the trace of the variation of the long period mode with c.g. shift that it is not possible to assume that the damping will be poorest at the most forward c.g. position, but may be critical at almost any c.g. This is in opposition to many popular theories.


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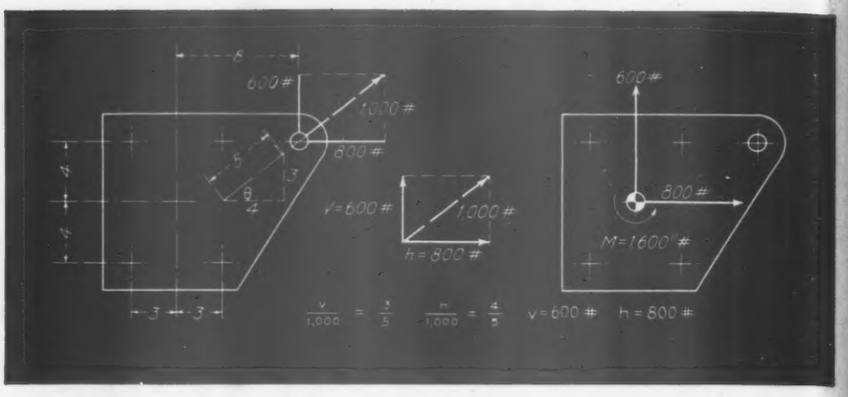


*Fig. 15. Given leading left, and equivalent loading rivets solved analytically.*

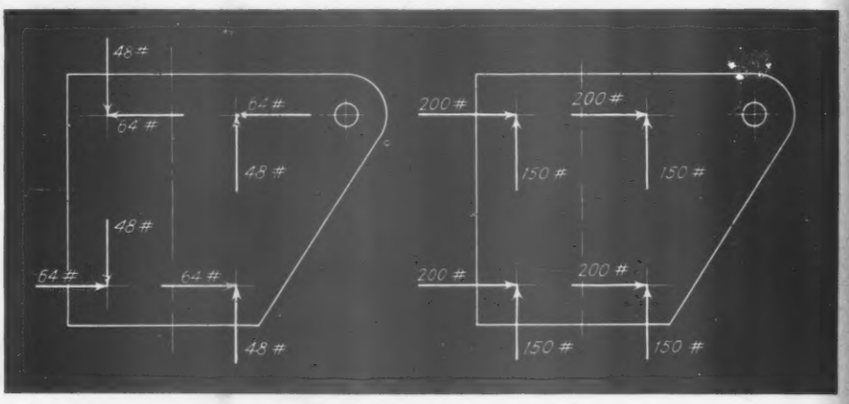


*Fig. 16. Rivet loads from moment, left, and rivet loads from central load.*

## Strength Analysis

(*Continued from page* 112)

force is applied to the bracket is used.

$$M = (600 \times 8) + (800 \times 4) = -4800 + 3200 = -1600 \text{ "\#}$$

$$\Sigma r^2 = \Sigma x^2 + \Sigma y^2 = 4(3)^2 + 4(4)^2 = 36 + 64 = 100$$

Rivet load from moment (vertical and horizontal components, Fig. 14)

$$P_{vm} = \frac{Mh}{\Sigma r^2} = \frac{1600 \times 3}{100} = 48 \text{ lb.}$$

$$P_{hm} = \frac{My}{\Sigma r^2} = \frac{1600 \times 4}{100} = 64 \text{ lb.}$$

Rivet load from central load (vertical and horizontal components, Fig. 15)

$$P_{vc} = \frac{600}{4} = 150 \text{ lb.}$$

$$P_{hc} = \frac{800}{4} = 200 \text{ lb.}$$

An inspection of the diagrams above indicates that the loading on the lower right hand rivet makes it the critical rivet since the corresponding components from both conditions of loading act in the same direction and therefore add together.

Total vertical load on critical rivet

$$R_v = 48 + 150 = 198 \text{ lb.}$$

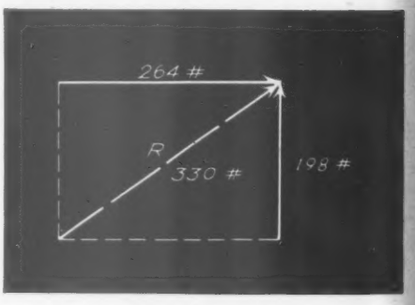


*Fig. 17. Diagram of resultant rivet load.*

Total horizontal load on critical rivet

$$R_h = 64 + 200 = 364 \text{ lb.}$$

Resultant rivet load

$$R = \sqrt{198^2 + 264^2} = \sqrt{39264 + 69696} \sqrt{108960} = 330 \text{ lb.}$$

## Altschul

(*Continued from page 180*)

capital investment.

With each decision, the CAB delineates additional principles governing the economic regulation of the air carriers. The American decision supplied many elements of rate making formerly lacking and will serve as an important influence in the future development of the industry.